PECVD報告

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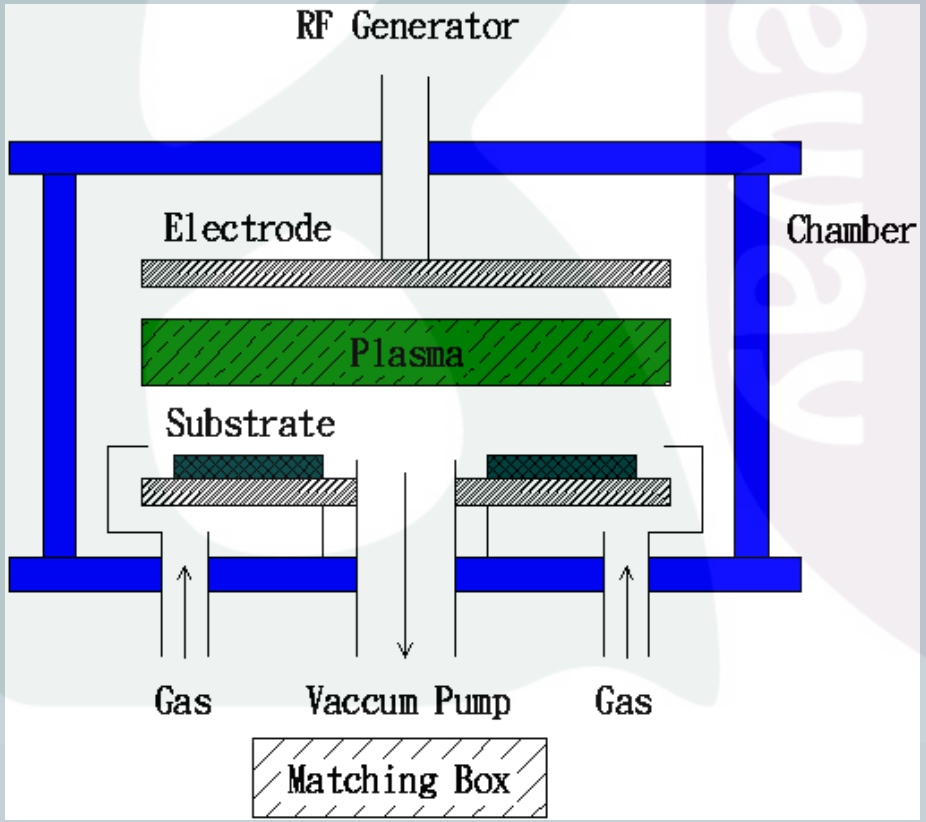
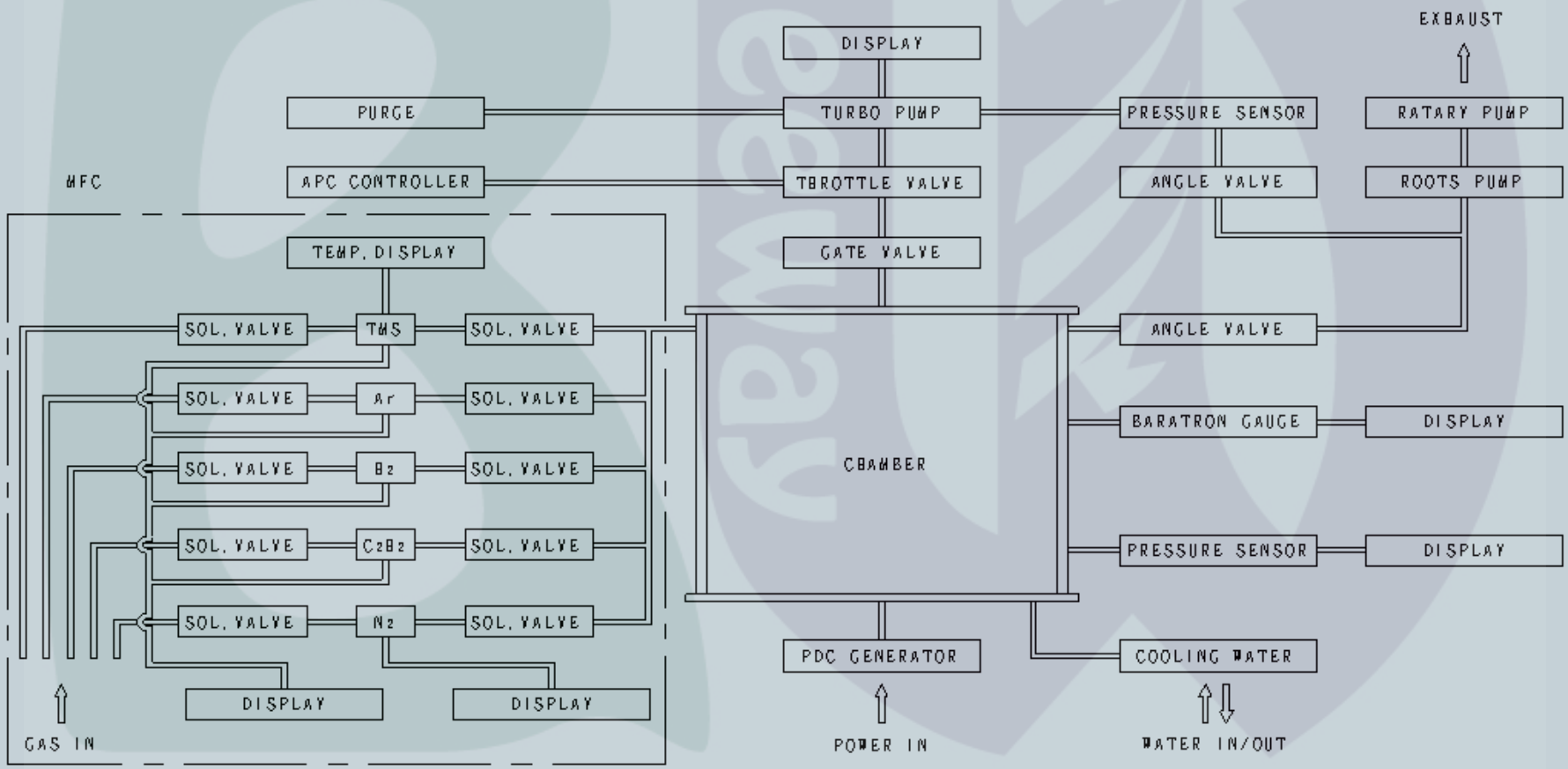
PECVD工作原理



- 腔體內有上下兩塊電極，工件置於下面的電極基板之上，電極基板加熱至100℃~400℃之間。
- 在二電極板間外加一個高頻的射頻(radio frequency，RF)電壓，此時在二極間會有輝光放射的現象。
- 反應氣體則是由沈積腔外緣處導入，流動通過輝光放射區域，而在沈積腔中央處由真空幫浦加以排出。

PACVD 系 統 架 構


DISPLAY
EXHAUST
PURGE
TURBO PUMP
PRESSURE SENSOR
RATARY PUMP
MFC
APC CONTROLLER
THROTTLE VALVE
ANGLE VALVE
ROOTS PUMP
TEMP. DISPLAY
GATE VALVE
SOL. VALVE
TMS
SOL. VALVE
ANGLE VALVE
SOL. VALVE
Ar
SOL. VALVE
BARATRON GAUGE
DISPLAY
SOL. VALVE
H2
SOL. VALVE
CHAMBER
SOL. VALVE
C2H2
SOL. VALVE
PRESSURE SENSOR
DISPLAY
SOL. VALVE
N2
SOL. VALVE
PDC GENERATOR
COOLING WATER
DISPLAY
DISPLAY
GAS IN
POWER IN
WATER IN/OUT

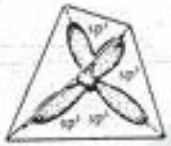
成功案例

DLC簡介　Diamond Like Carbon

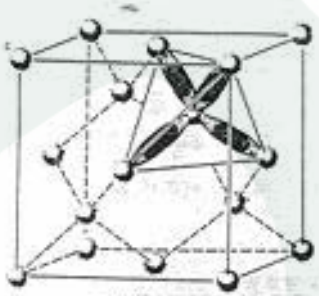
- DLC技術於1970年代初期被發展出來，是Diamond Like Carbon（類鑽碳)的簡稱，本質是一種含氫的非晶質碳膜，特性接近於高硬度的鑽石。

- DLC為類石墨鍵(Graphite-Like Bond or sp^2)及類鑽石鍵(Diamond-Like Bond or sp^3)所結合的非晶質碳薄膜。純DLC又稱為無晶鑽石(a-D)，另一種DLC內含大量氫，稱為氫化DLC(a-c:H)。

Diamond



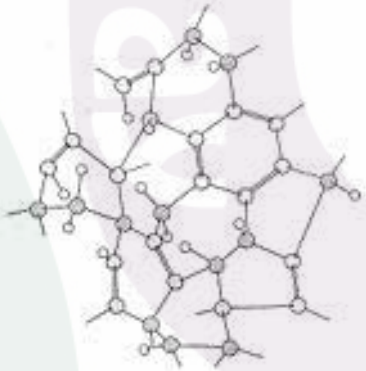
(1)



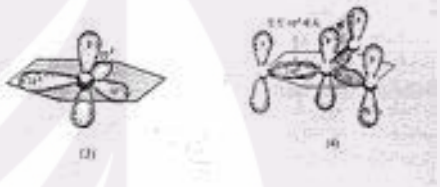
(2)

DLC

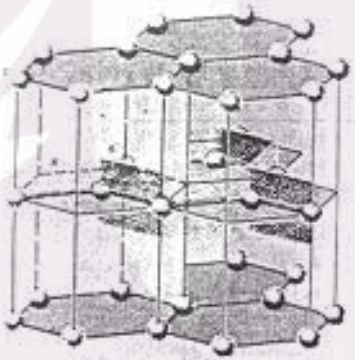
- ✓ **Diamond like carbon**
  - high hardness
  - high wear resistance
  - chemical inertness
  - electrical resistance
- ✓ **Amorphous St.**
- ✓ **Mixture of sp^1, sp^2, sp^3**



Graphite



(3) (4)



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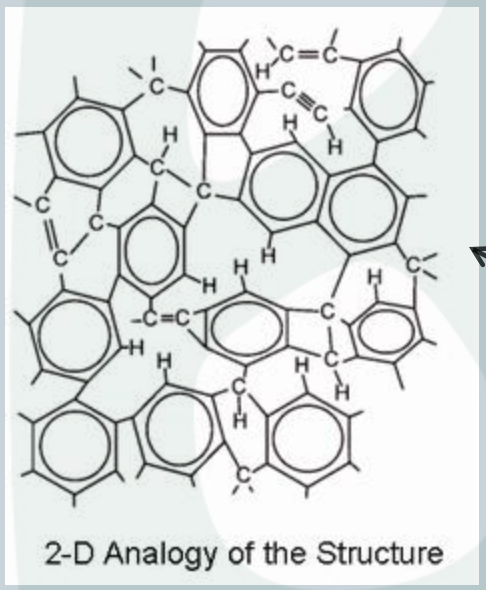
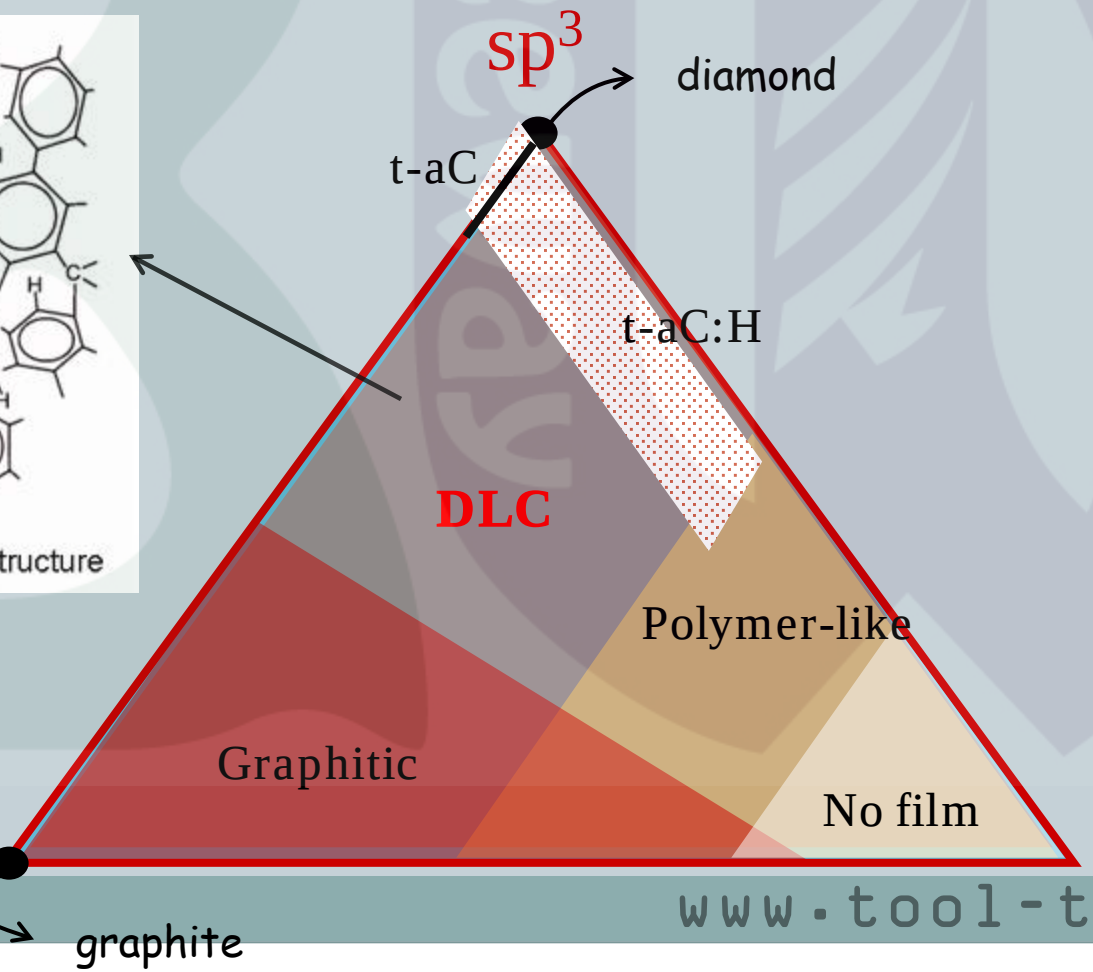
Classification of Solid Carbon-(Hydrogen)





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DLC運用於微鑽針之特性

- **耐腐蝕** — 不與銅，鋁材質反應
- 高硬度 — Hv硬度2500~6000，耐磨耗
- **低摩擦係數** — 無潤滑之摩擦係數在0.05~0.2
- **離模性高** — 減少軟質金屬凝附
- 膜層平滑 — 減少鑽屑堆積
- 熱傳係數高 — 避免鑽針過熱

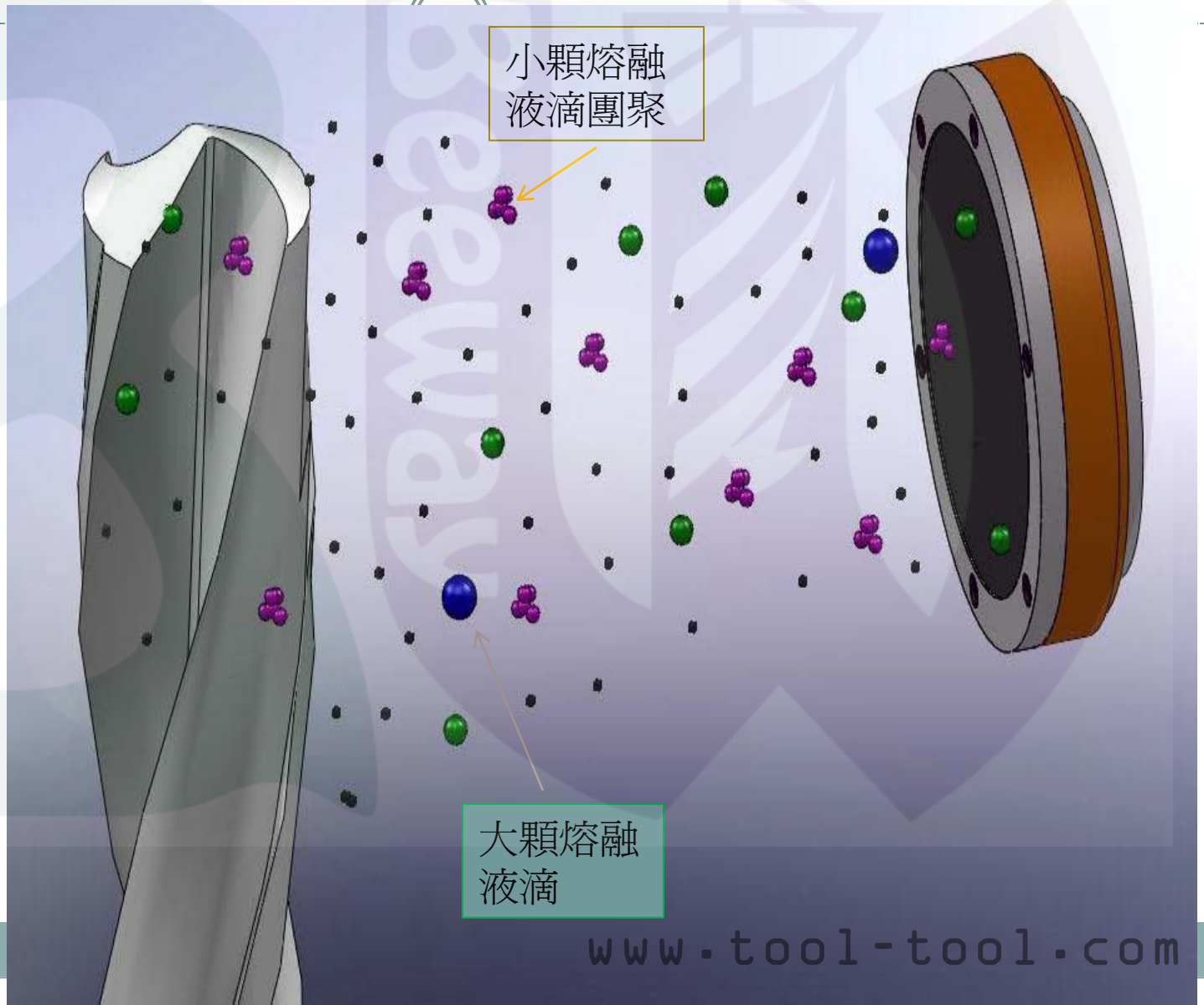
DLC特性比較表

Property	Diamond	DLC	Graphite
Density (g/cm^3)	3.51	1.8 - 3.6	2.26
Atomic Number Density ($Mole/cm^3$)	0.3	0.2 - 0.3	0.2
Hardness (Kgf/mm^2)	10000	2000 - 8000	500
Friction Coeff.	0.05	0.03 - 0.2	0.1
Refractive Index	2.42	1.8 - 2.6	2.15 - 1.8
Transparency	UV-VIS-IR	VIS-IR	Opaque
Resistivity (Wcm)	$>10^{16}$	10^{10} - 10^{13}	0.2 - 0.4

不同DLC設備成膜方法比較

成膜原理	陰極電弧法	電漿化學氣相沈積	非平衡磁控濺鍍
	ARC	Plasma CVD	UBMS
成膜原料	固體碳	C2H2（氣體）	固體碳
成膜溫度	~400	~200	~250
膜組成	可能無氫	含氫	可能無氫
摩擦係數	0.2~0.5	0.1~0.2	0.1~0.2
硬度	2000~8000	1500~6000	**1000~2000**
表面粗度	**尚可(Ra~10um)**	佳(Ra~0.02um)	可(Ra~0.1um)
附著力	佳	佳	弱
絕緣性	佳	可	Me-DLC為**導電**

陰極電弧法(Arc)與濺鍍法原理(UBM)



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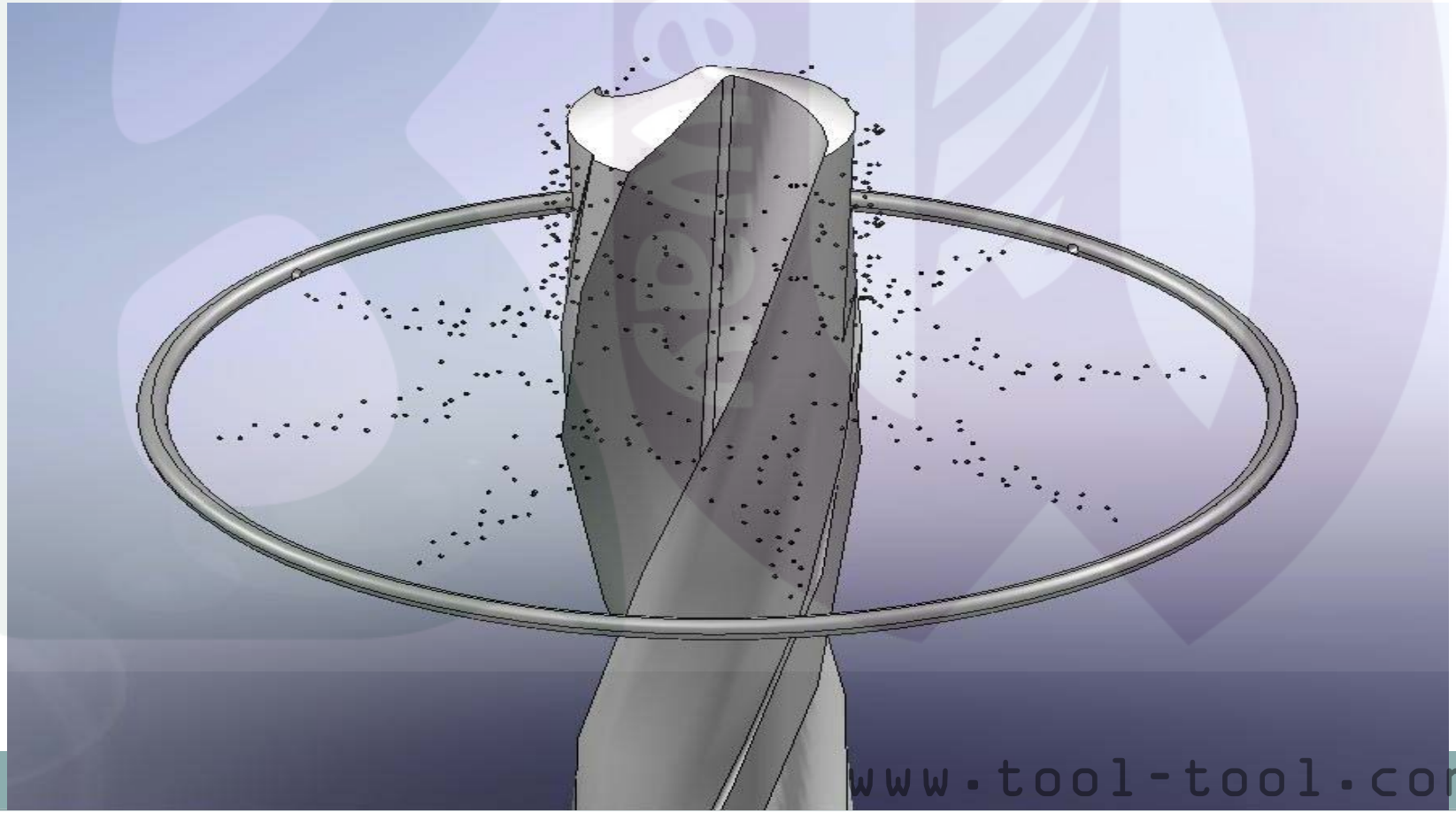
電漿輔助化學反應氣相鍍膜(PECVD)

乙炔氣體＋電磁波→類鑽碳膜(DLC)



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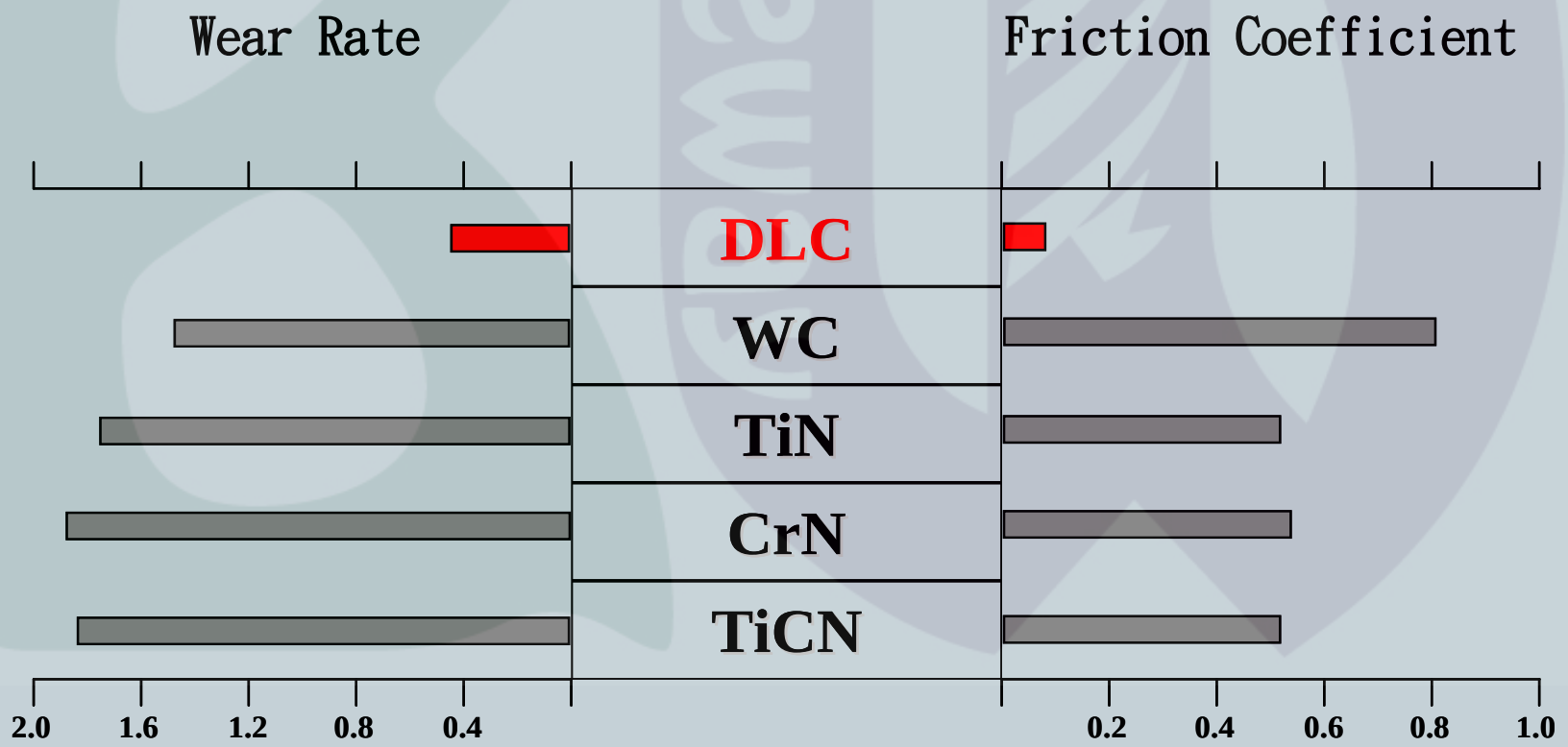
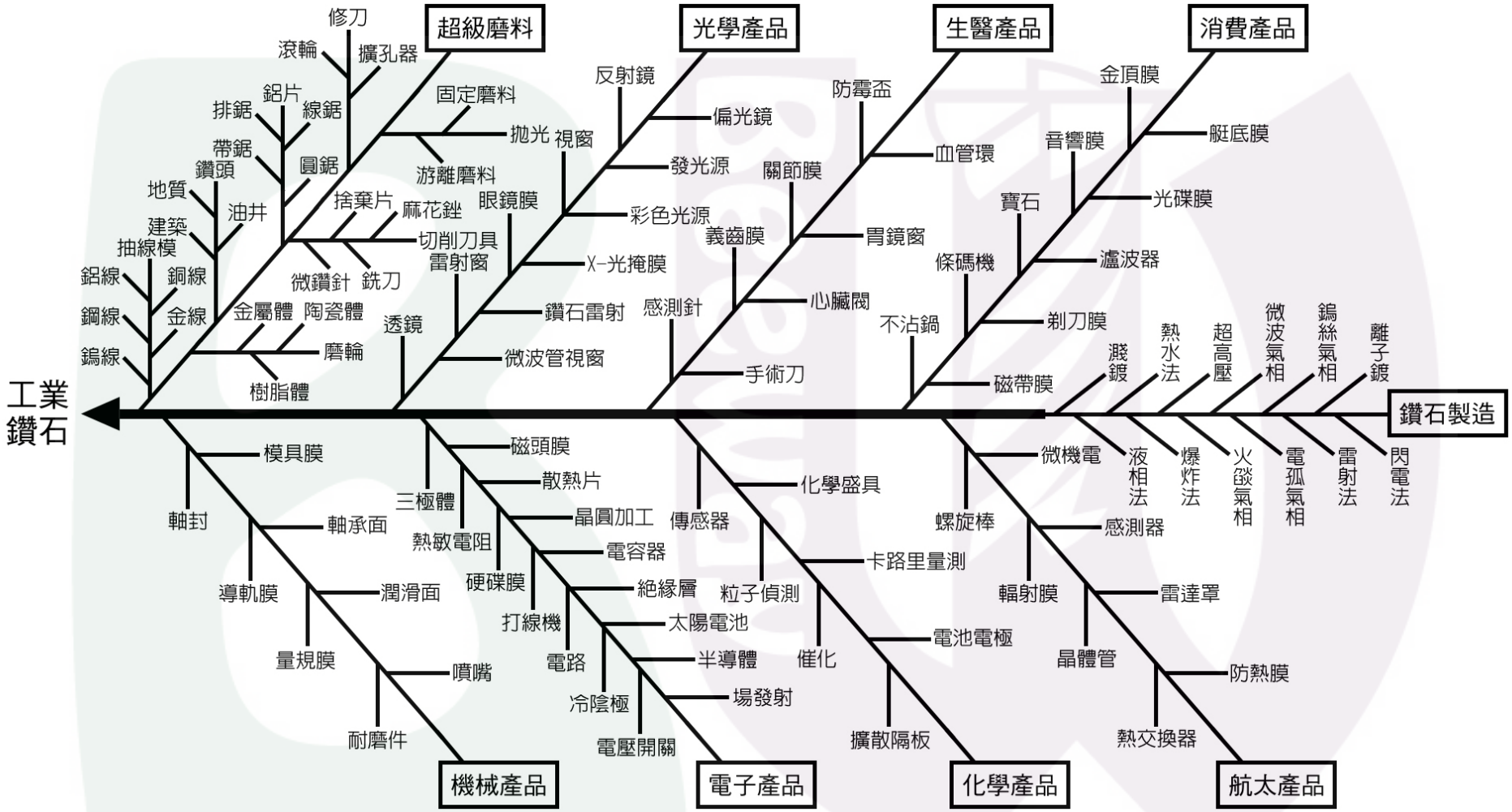
DLC的優勢(Pin on Disk Test)





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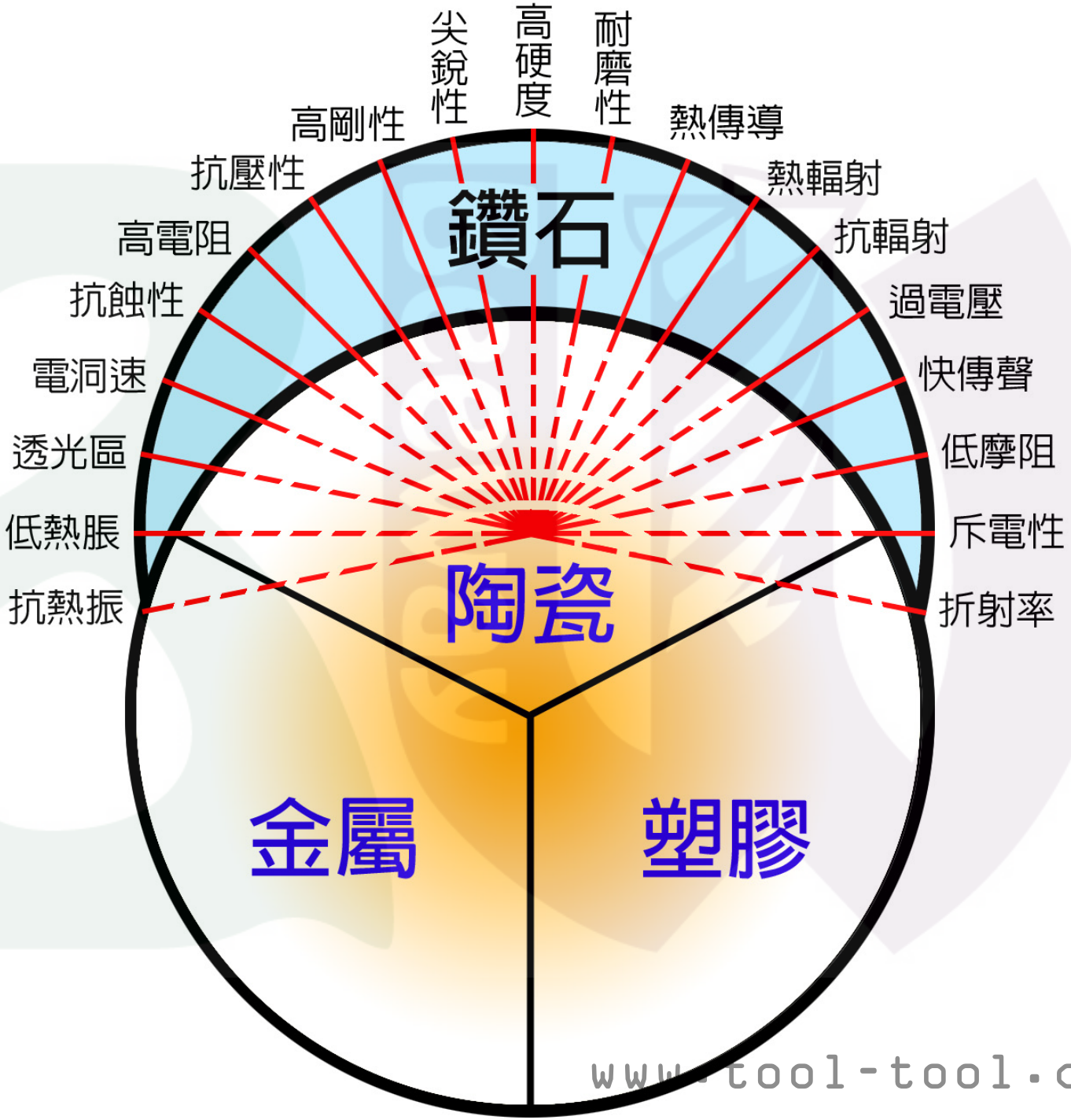

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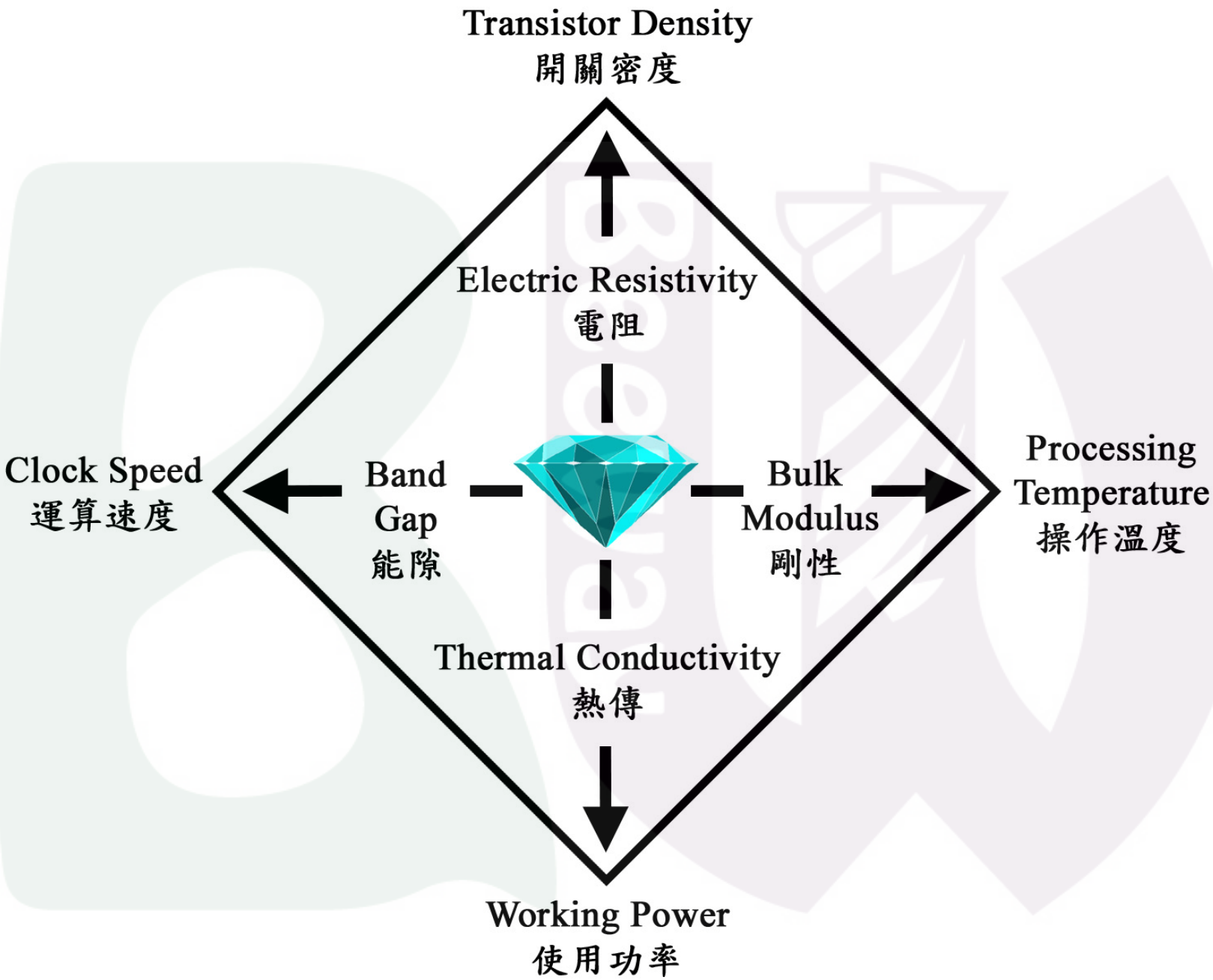
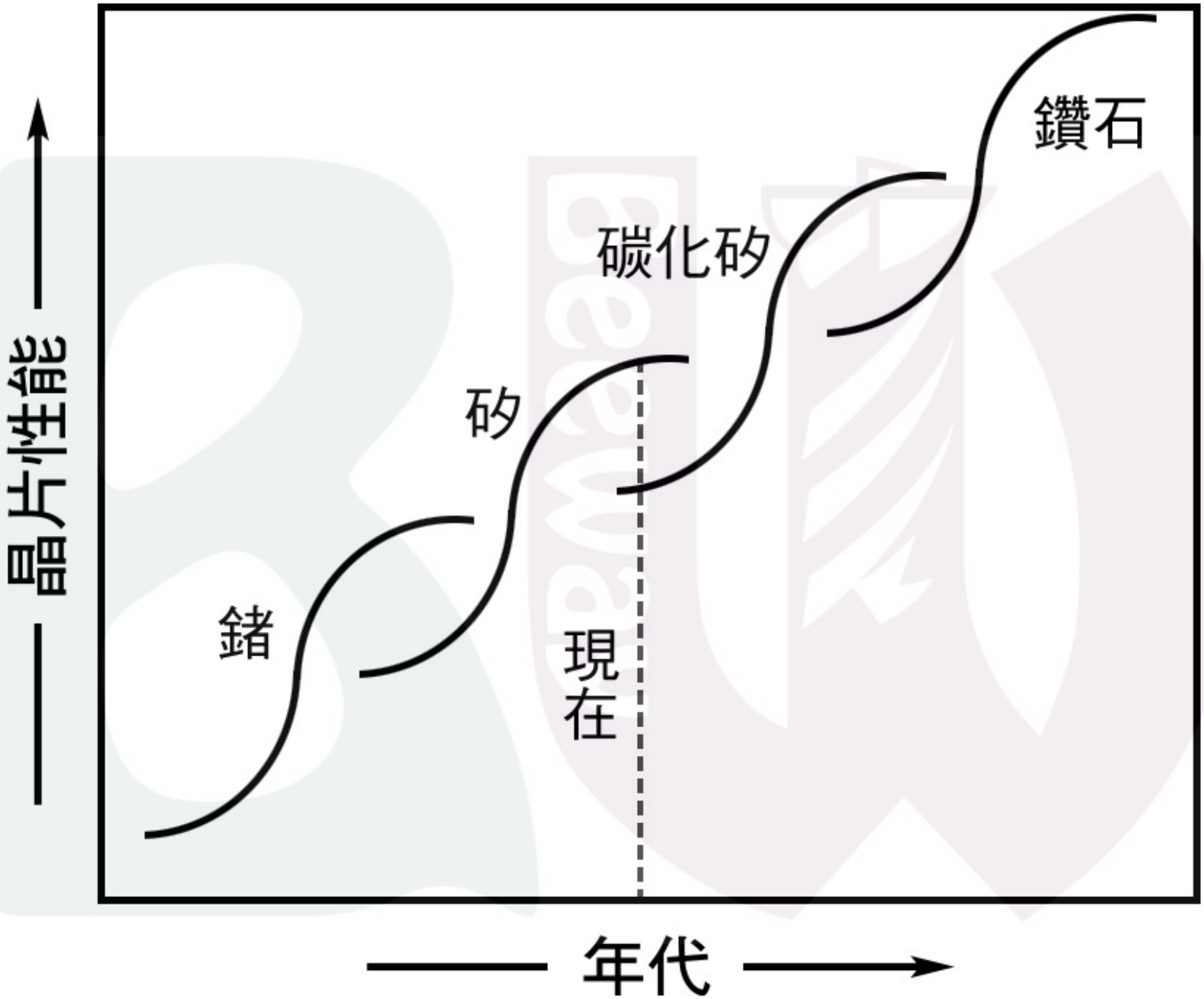

Transistor Density
開關密度
Electric Resistivity
電阻
Clock Speed
運算速度
Band
Gap
能隙
Bulk
Modulus
剛性
Processing
Temperature
操作溫度
Thermal Conductivity
熱傳
Working Power
使用功率



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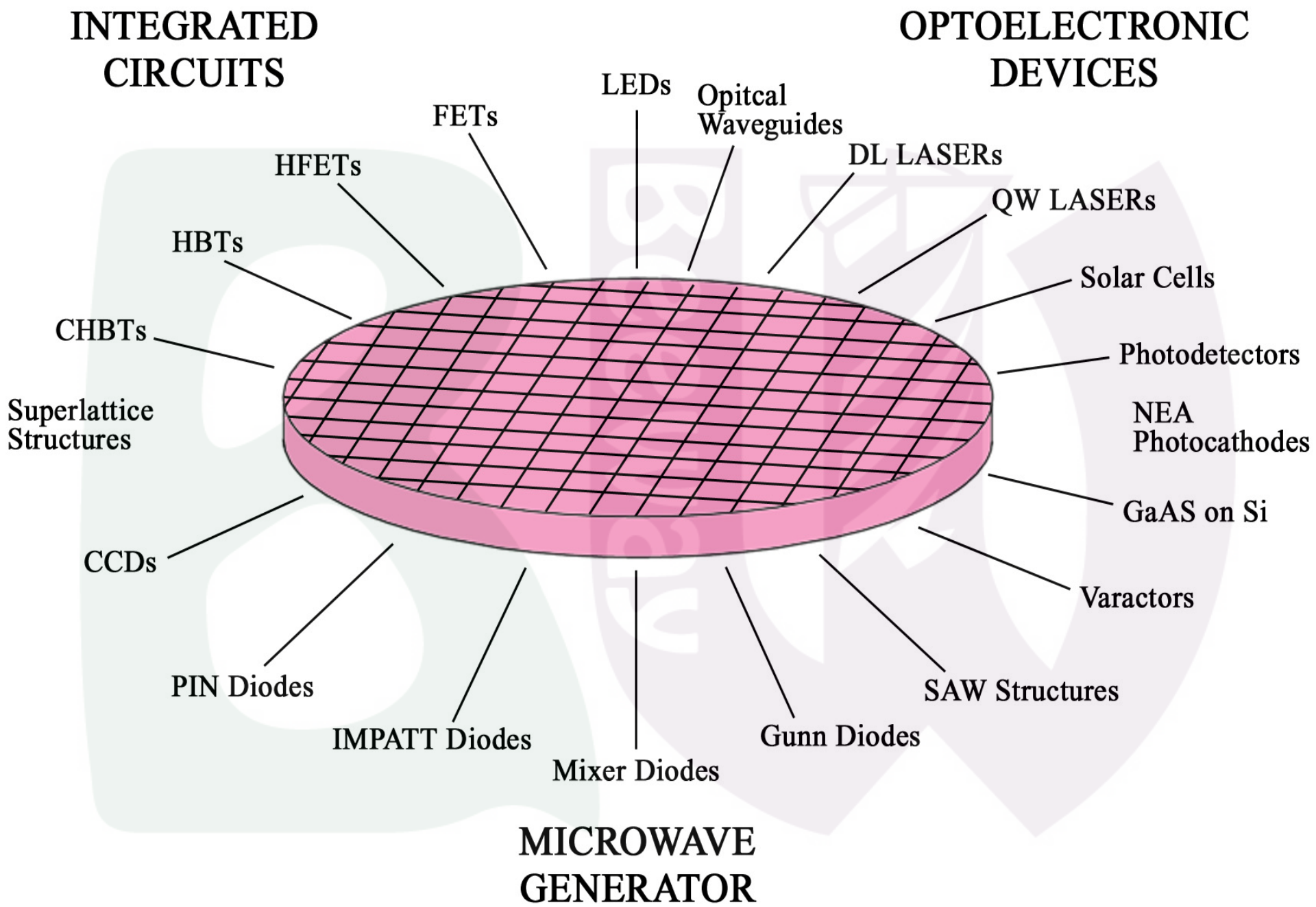

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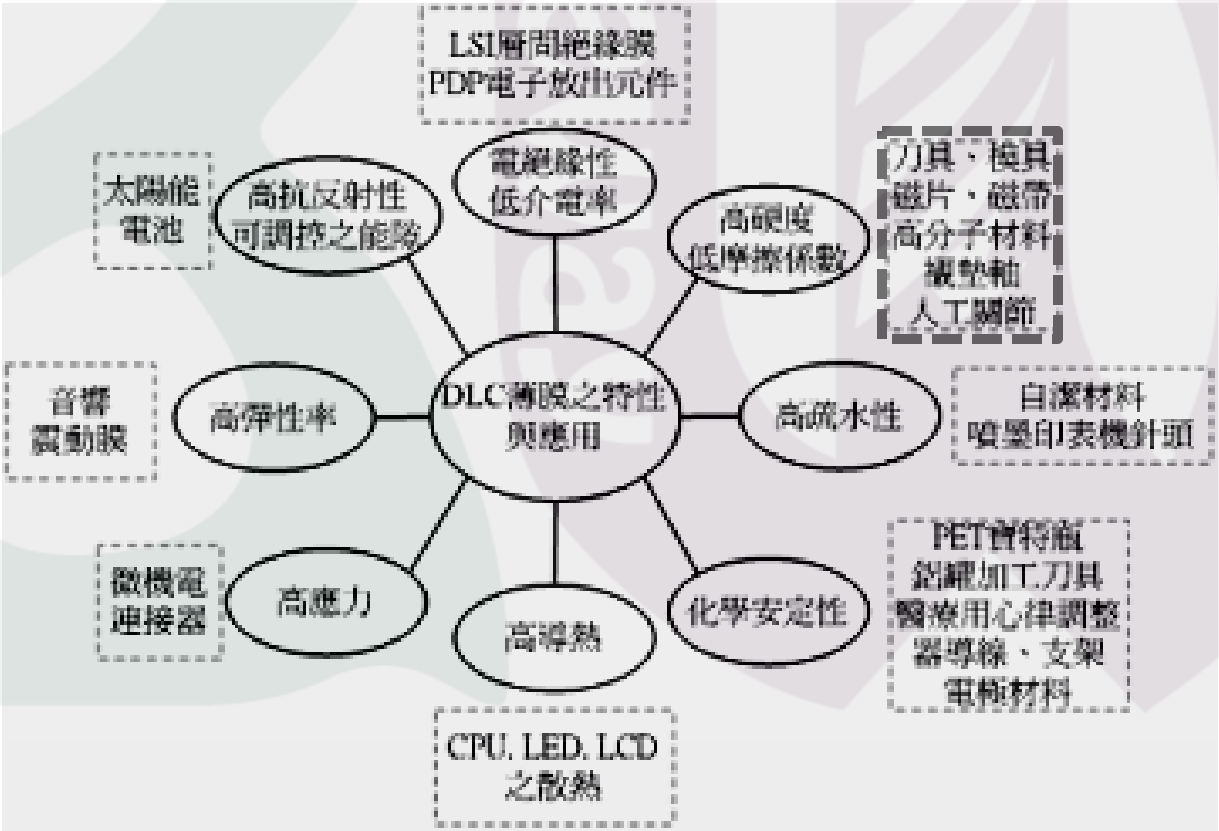
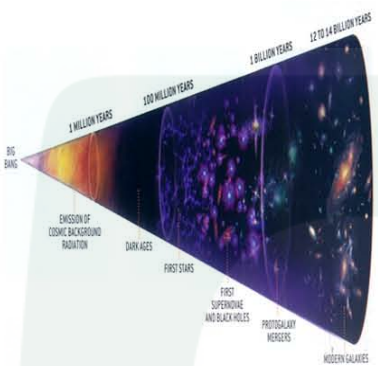
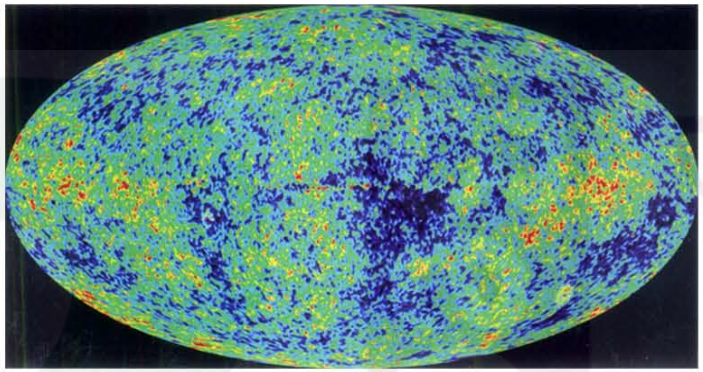
DLC 薄膜應用


LSI層間絕緣膜
PDP電子放出元件
電絕緣性
低介電率
太陽能
電池
高抗反射性
可調控之能隙
高硬度
低摩擦係數
刀具、模具
磁片、磁帶
高分子材料
緩墊軸
人工關節
音響
震動膜
高彈性率
DLC薄膜之特性
與應用
高疏水性
自潔材料
噴墨印表機針頭
微機電
連接器
高應力
高導熱
化學安定性
PET寶特瓶
鋁罐加工刀具
醫療用心律調整
器導線、支架
電極材料
CPU, LED, LCD
之散熱

God's Light



Big Bang



Microwave

Sun

Lightning

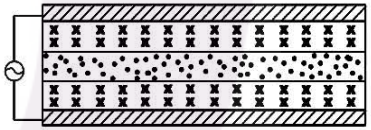
Man's Light

15 lm/w (2 %)
$ 0.5/klm

70 lm/w (10 %)
$ 1.5/klm

LED

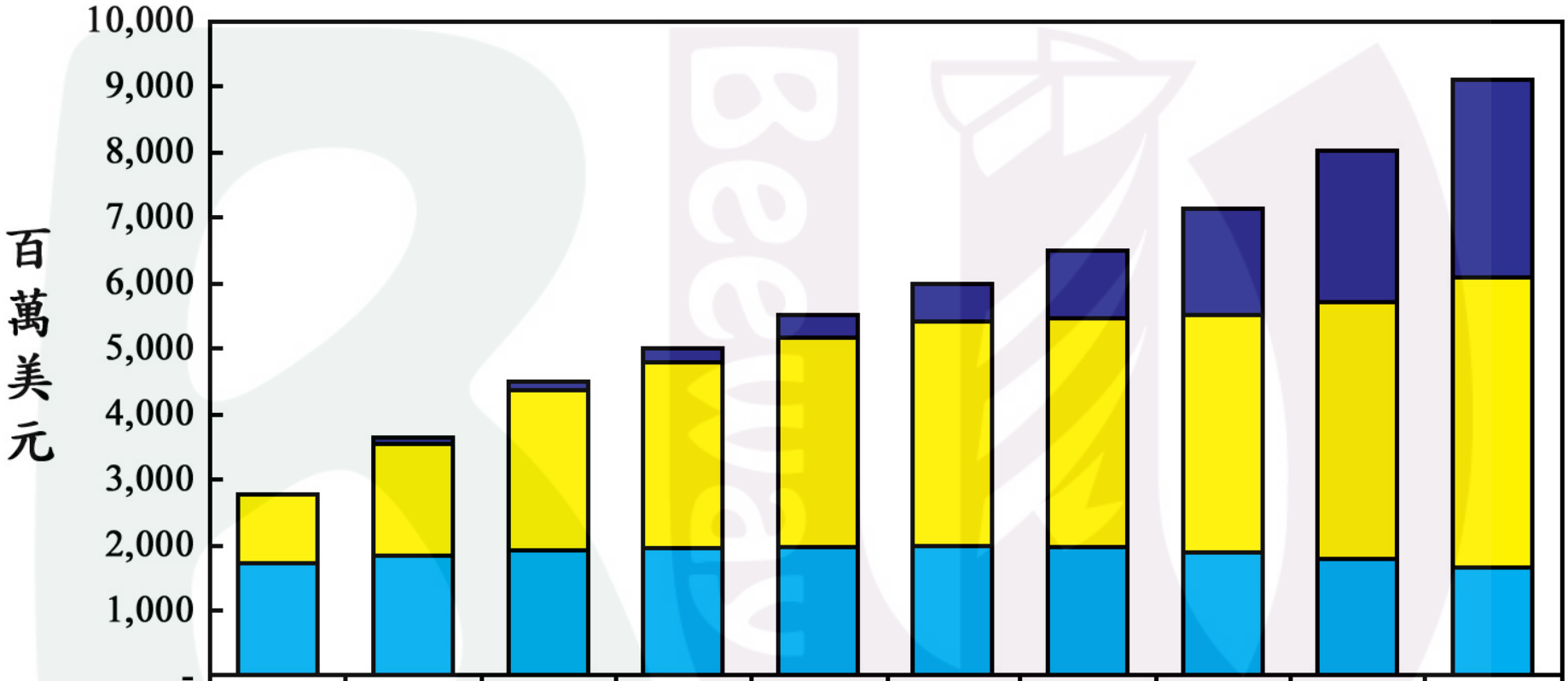
40 lm/w (6 %)
$20 /klm



OLED
DEL

100 lm/w (15 %)
$ 0.5 /klm
(Potential)

1 lumen at maximum sensitivity (555nm) = 0.0015w (1w = 680 lm) , 1 klm = 1000 lumens.



	2002年	2003年	2004年	2005年	2006年	2007年	2008年	2009年	2010年	2011年
超高亮度LED	-	17	81	198	346	591	1,063	1,621	2,293	3,024
高亮度LED	1,008	1,711	2,480	2,818	3,165	3,411	3,492	3,633	3,928	4,448
標準型LED	1,749	1,859	1,932	1,978	2,006	2,007	1,975	1,909	1,806	1,668

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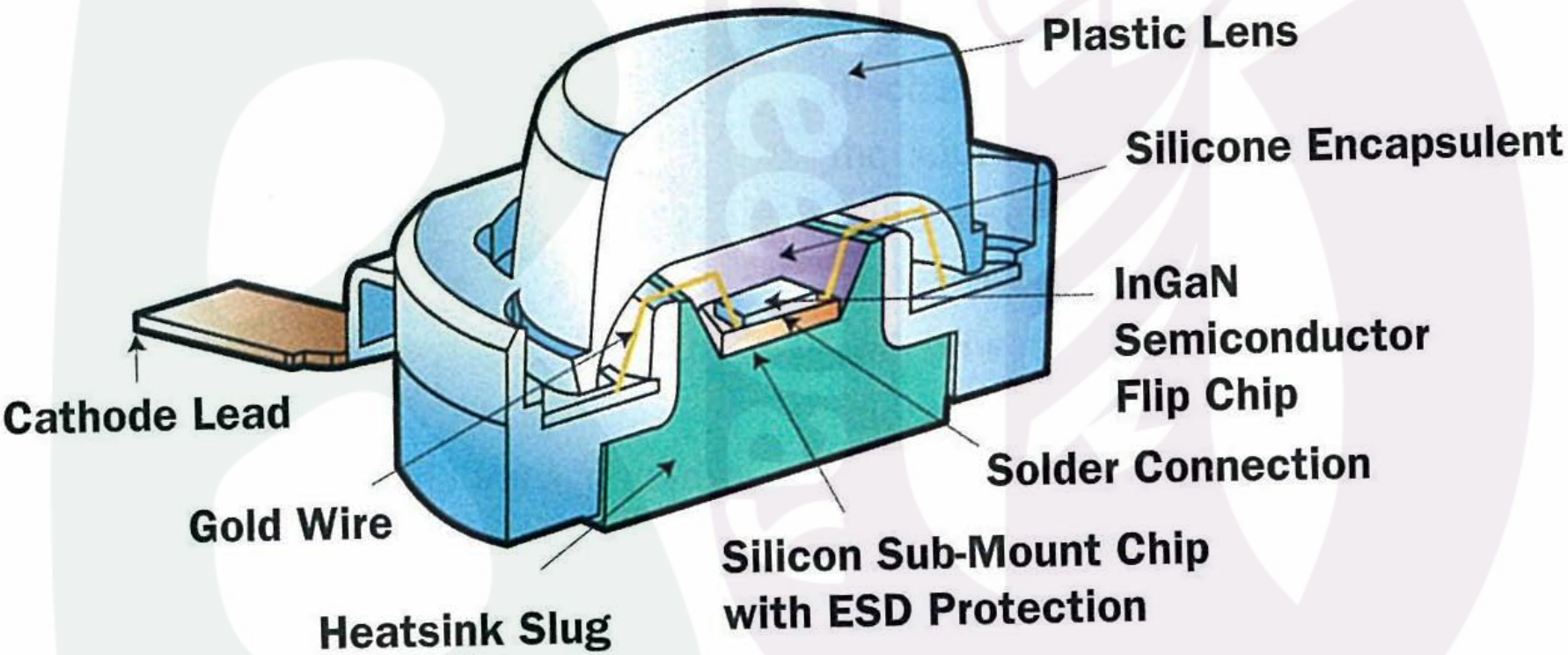

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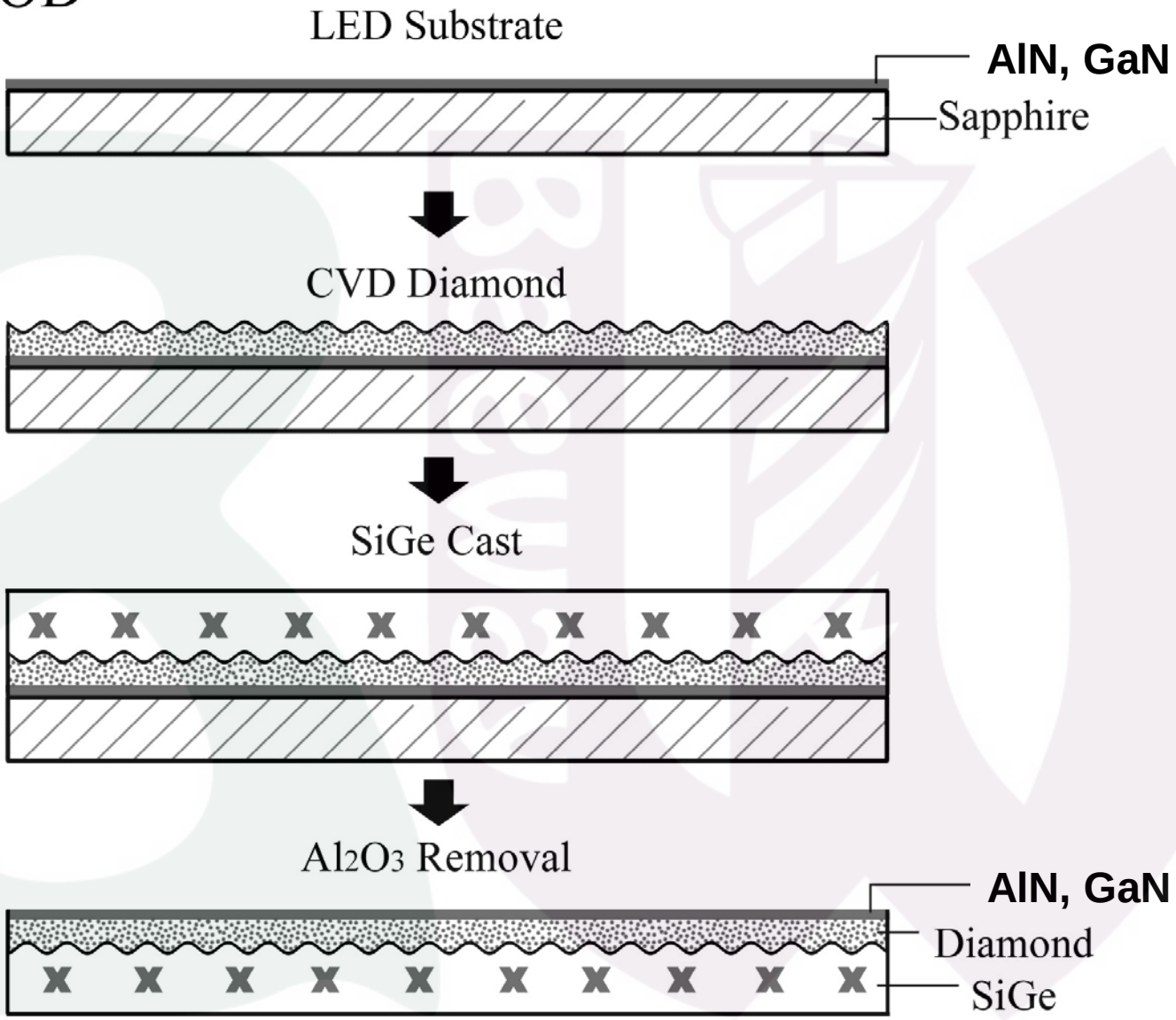
LED SOD



SOD

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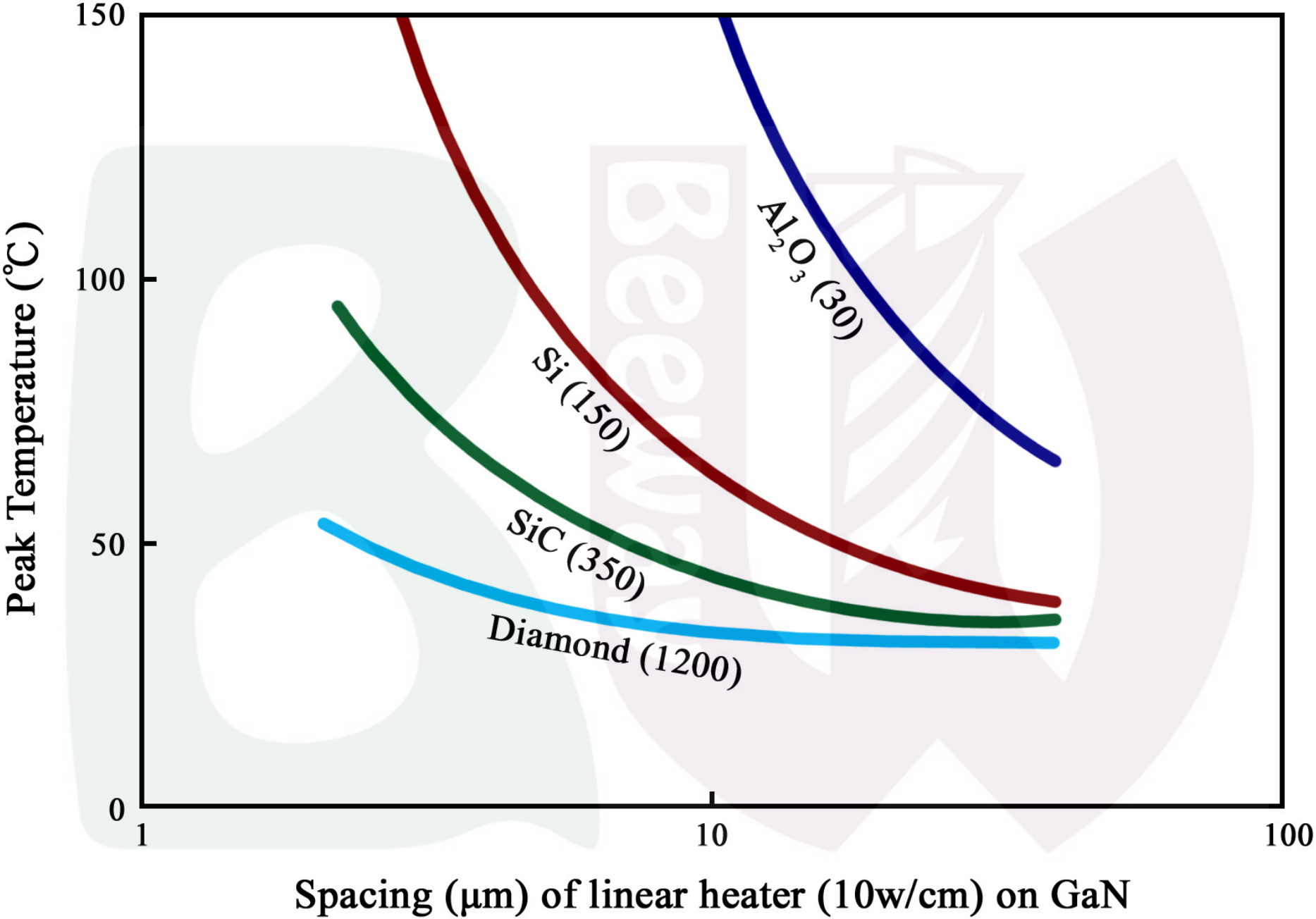

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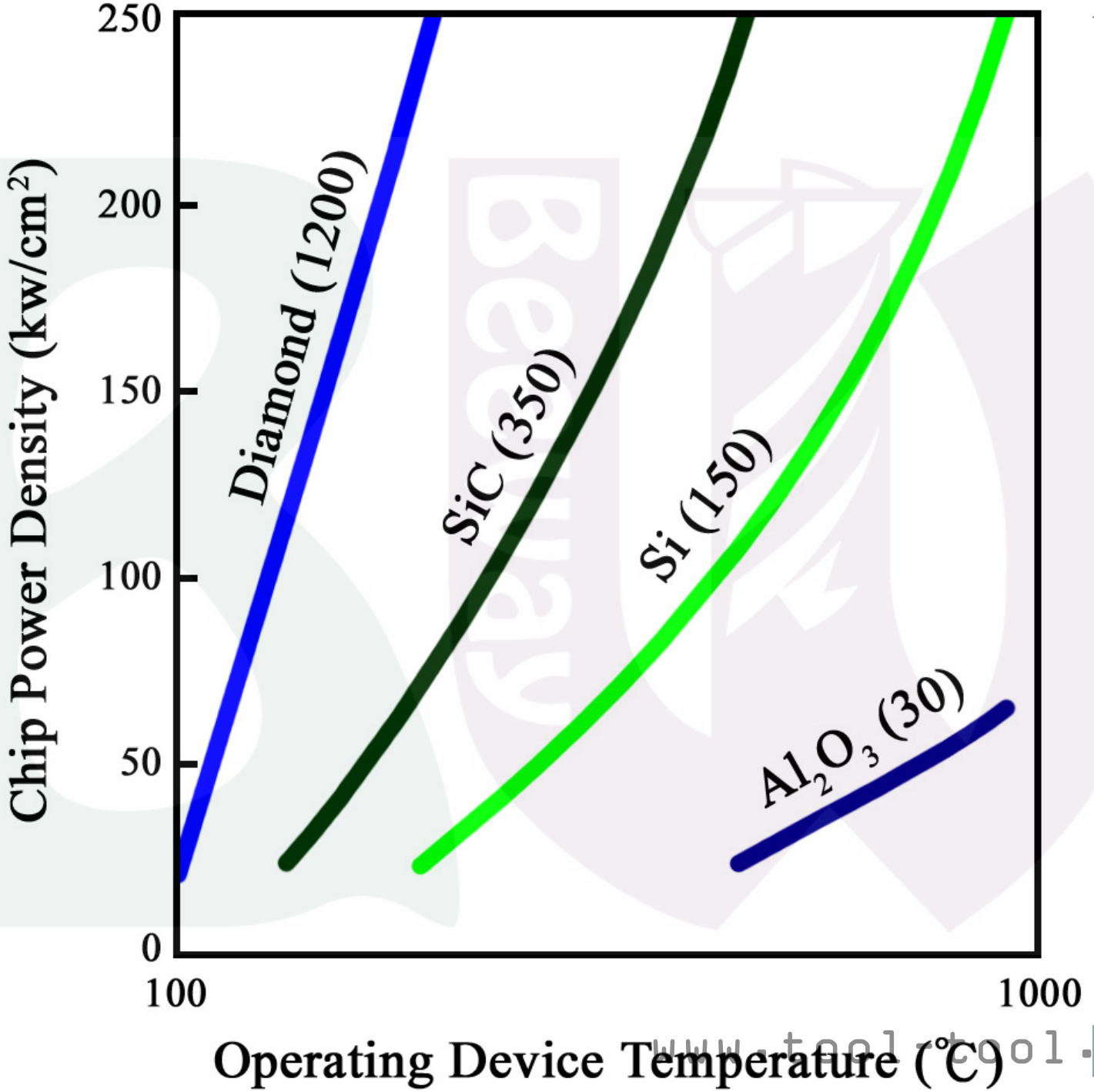

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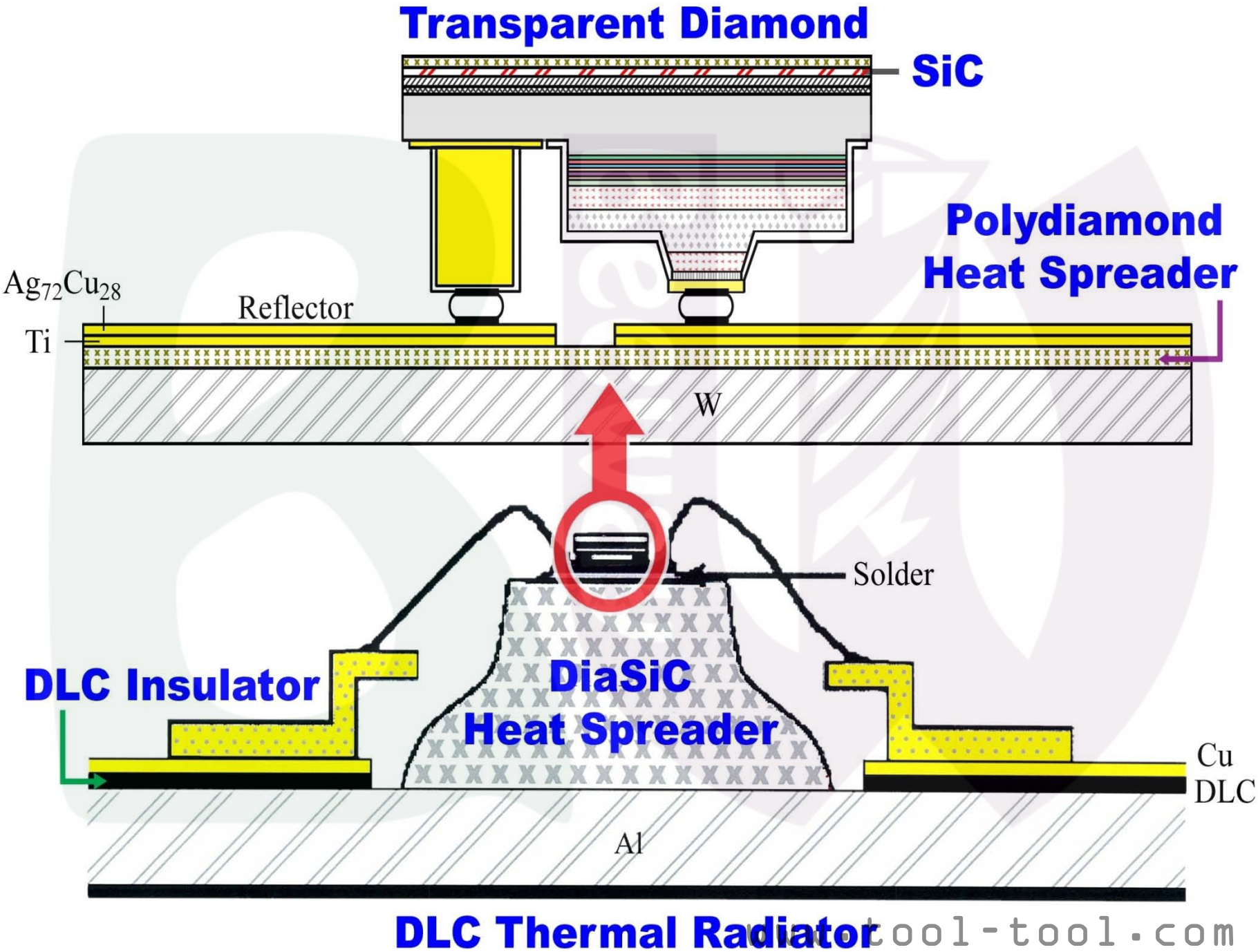

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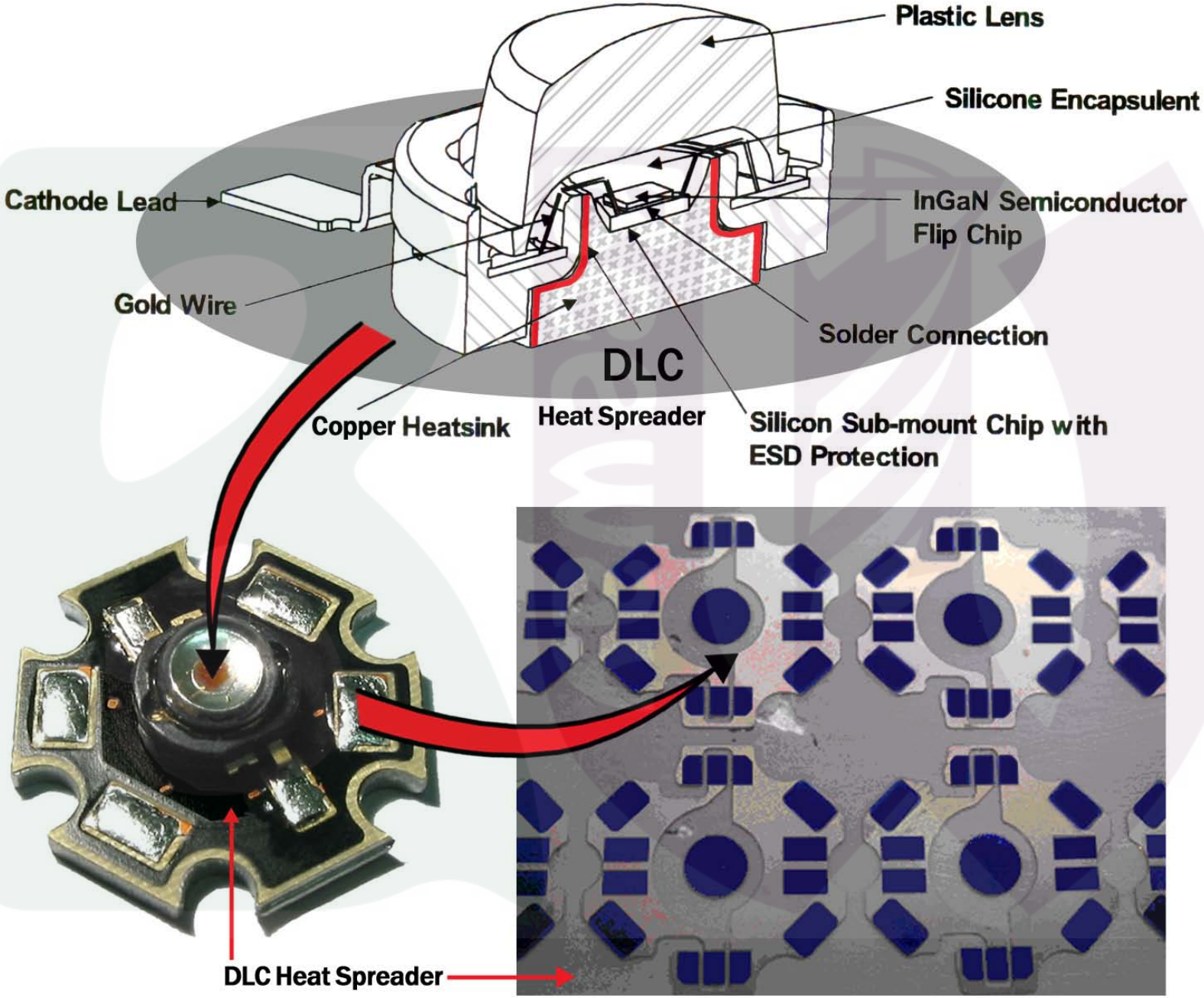
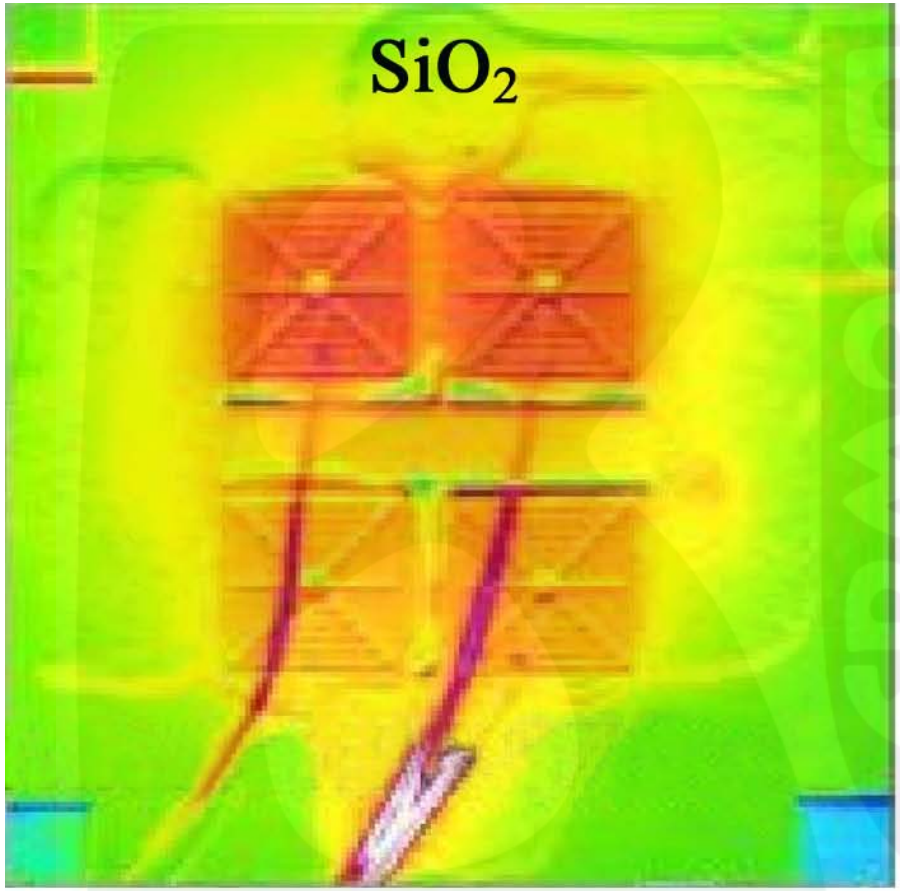
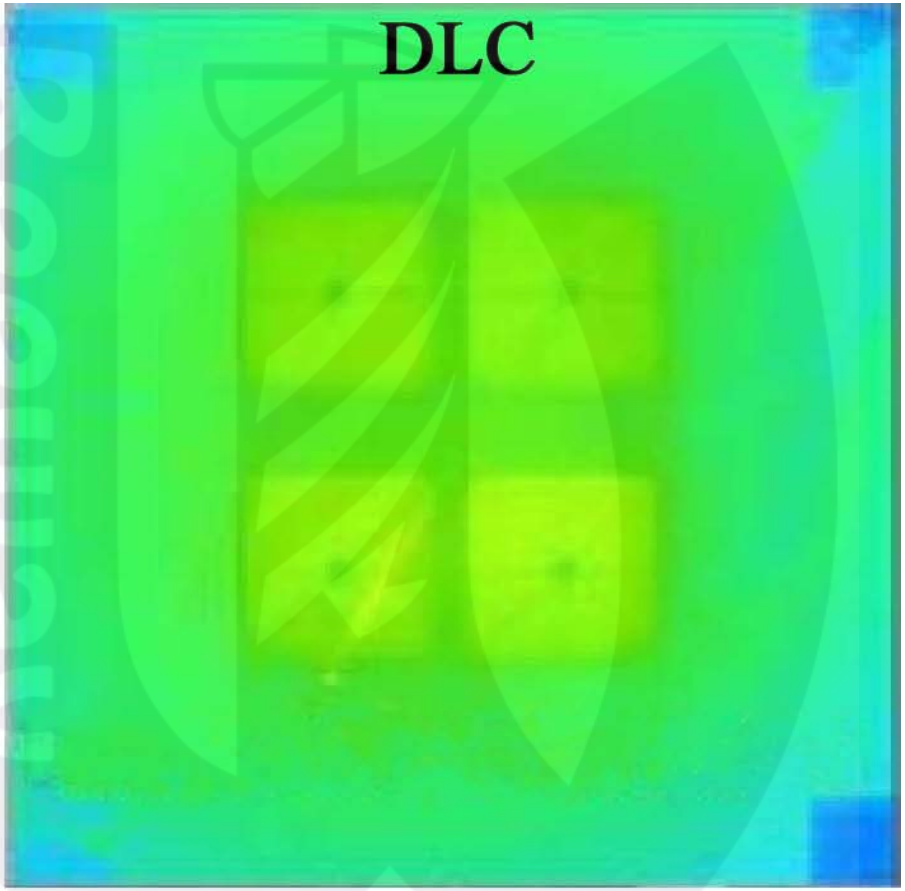
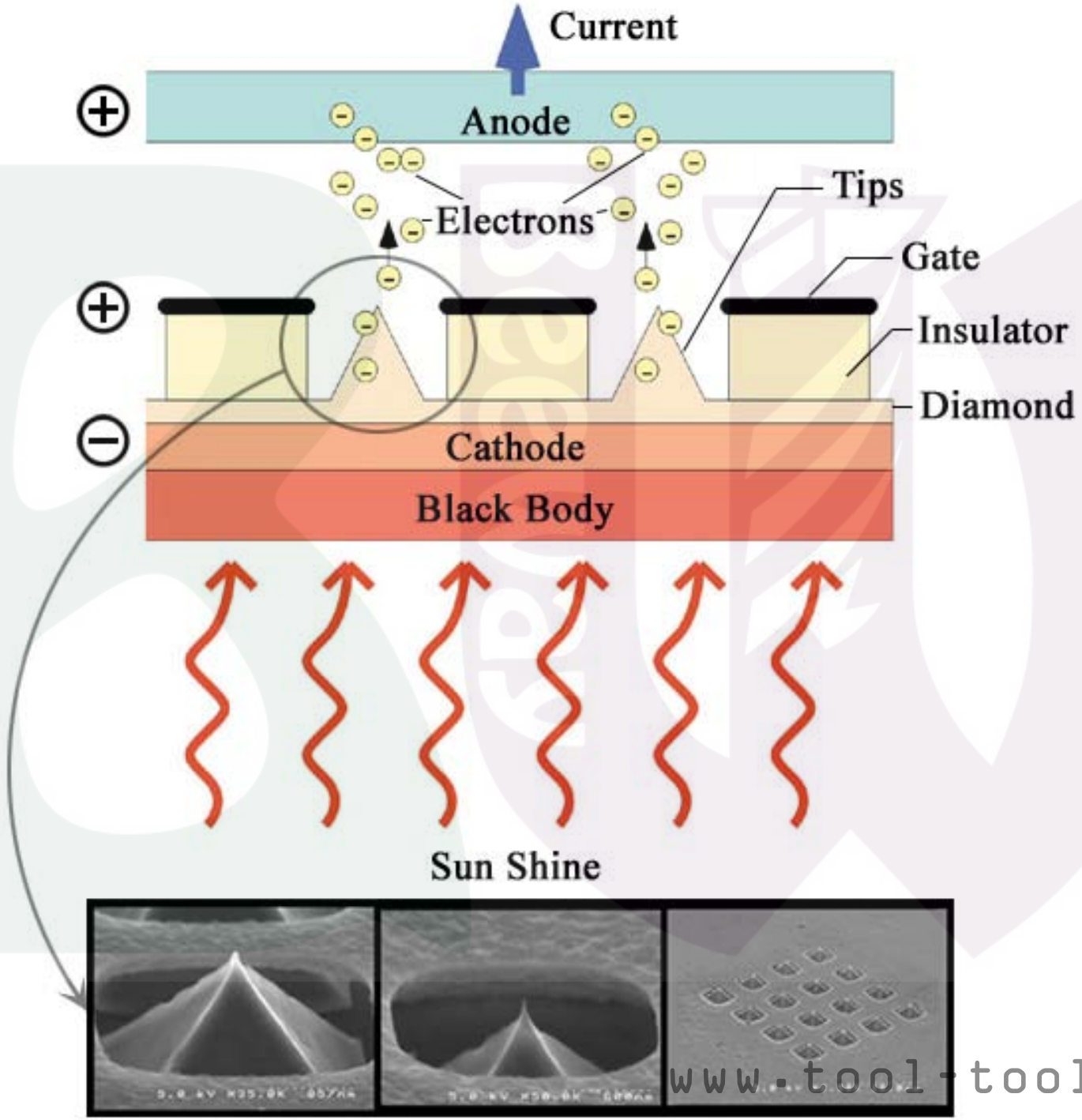

Plastic Lens
Silicone Encapsulent
Cathode Lead
InGaN Semiconductor
Flip Chip
Gold Wire
Solder Connection
DLC
Copper Heatsink
Heat Spreader
Silicon Sub-mount Chip with
ESD Protection
DLC Heat Spreader



104℃



88℃



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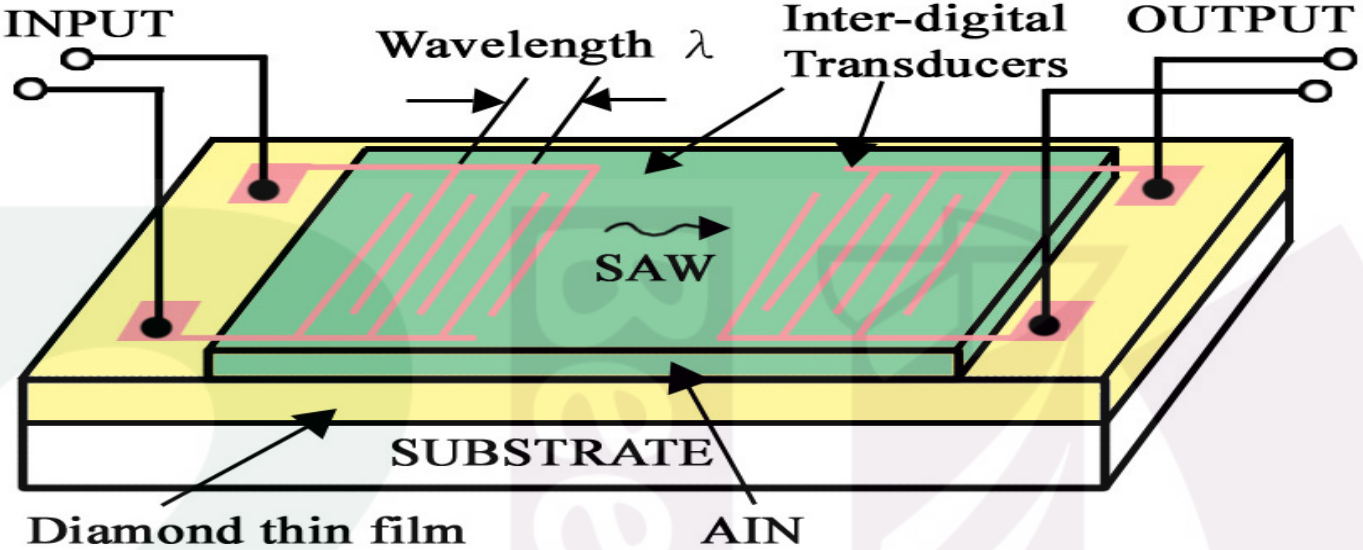

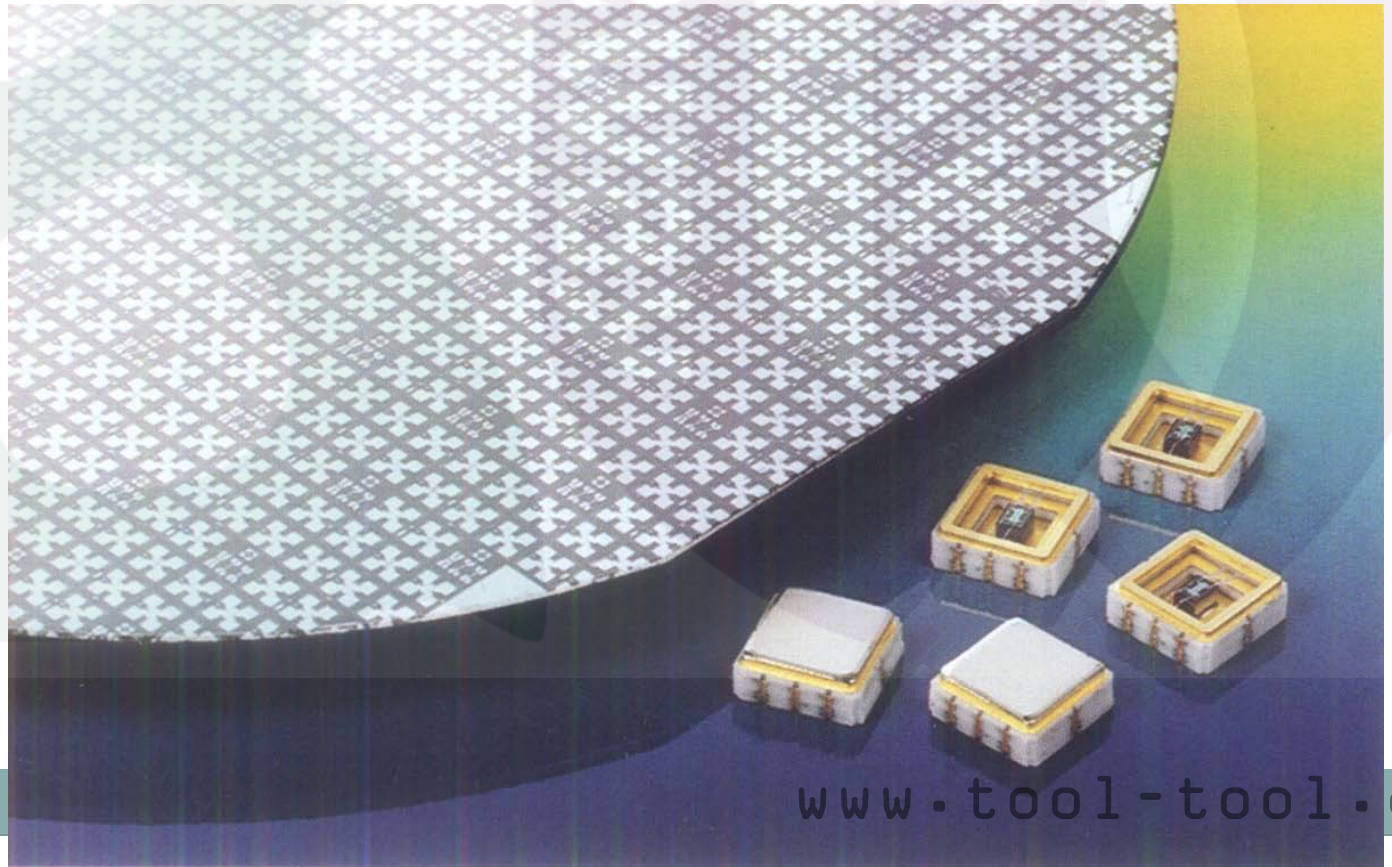

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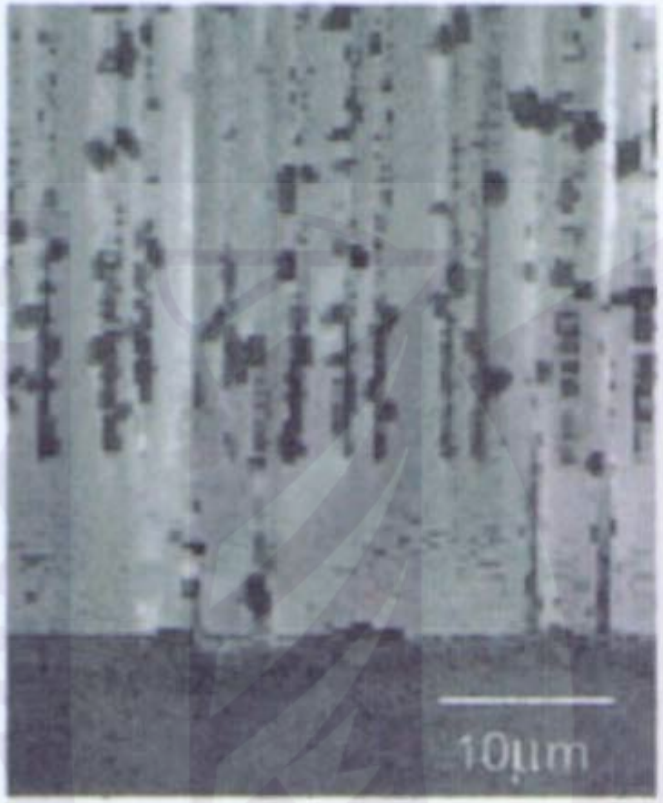

Diamond

Applied power
(~3.8W)

$LiTaO_3$

Applied power
(~0.6W)

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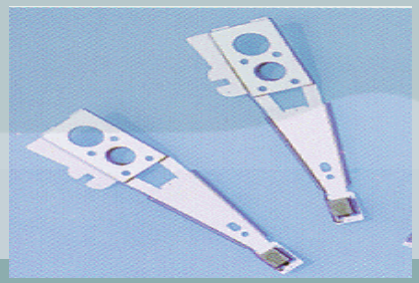
DLC應用面

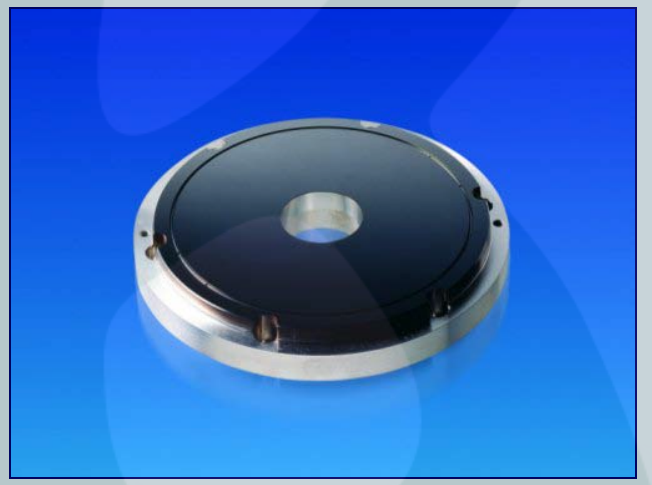
高硬度、高耐磨、低摩擦以及平滑等特性，使DLC能應用在許多領域當中。

Hard Disk

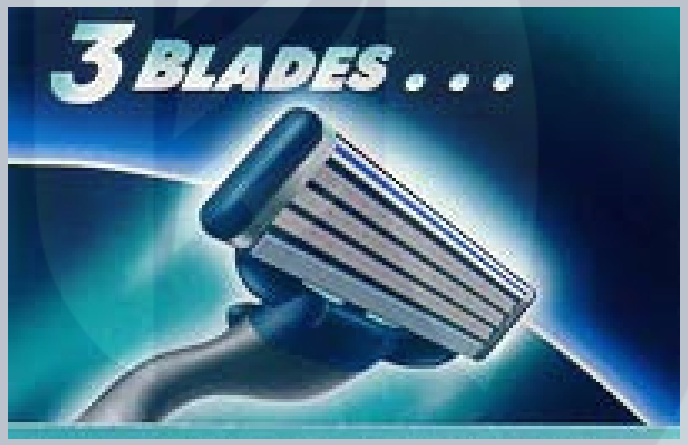
Maching Tool



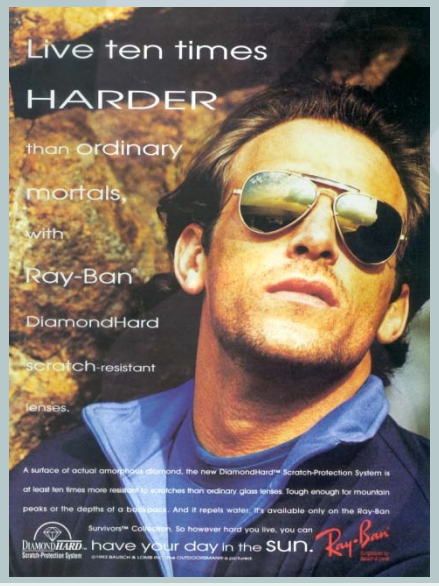
DLC應用面



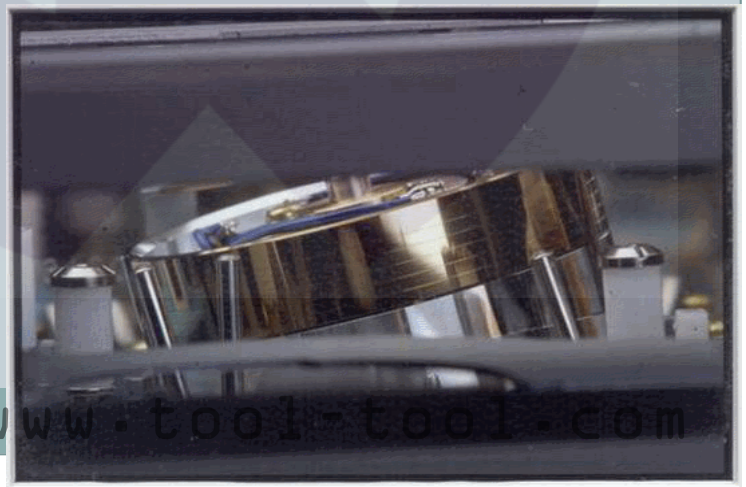
CD-R Pressing Die



DLC應用面

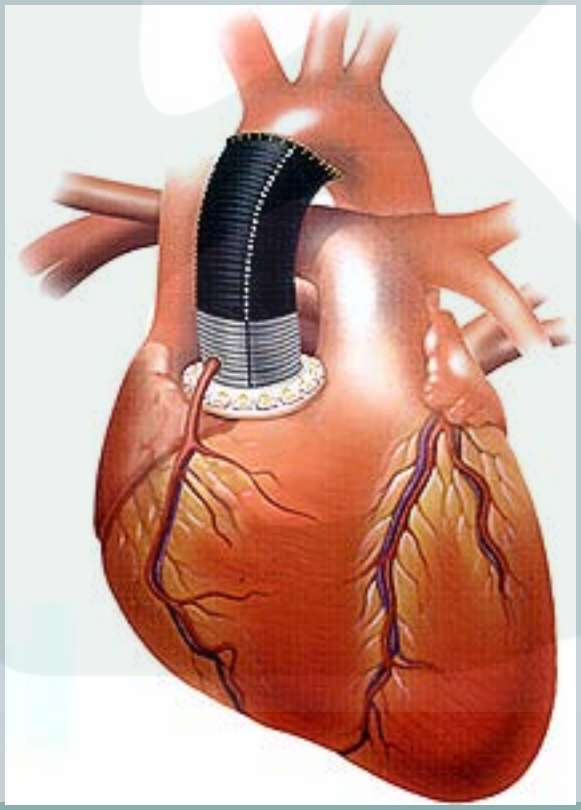


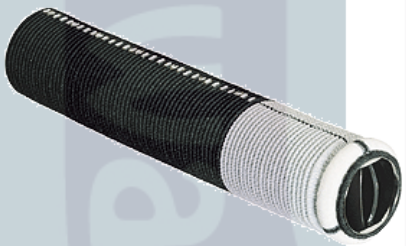
Sun Glasses



Video Head Drum

DLC應用面





Mechanical Heart Valve

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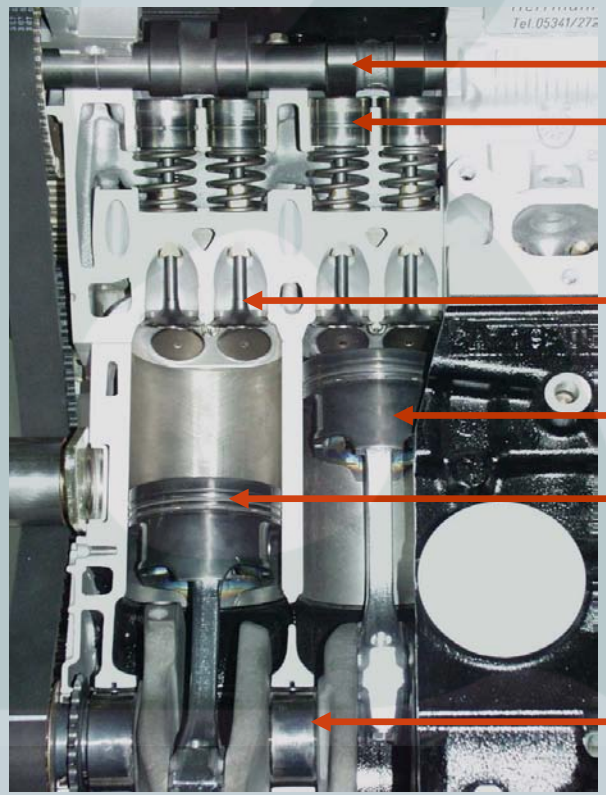
DLC應用面



camshaft
tappets
valves
piston
piston ring
crankshaft

Engine

Spur Gear

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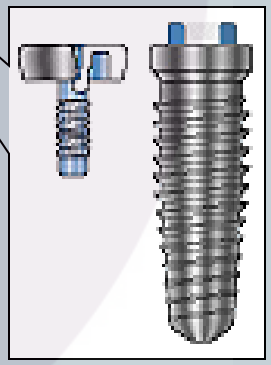
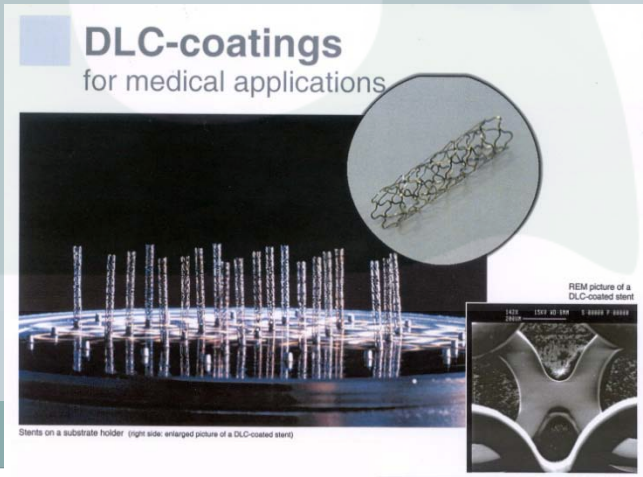
DLC應用面

Hip Joint



Hip Joint



Coronary Artery Stent

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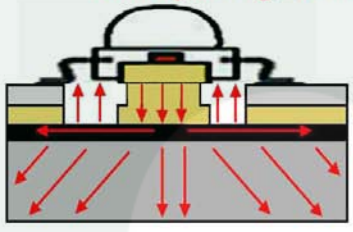
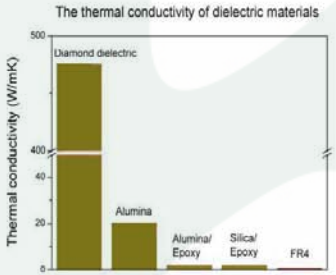
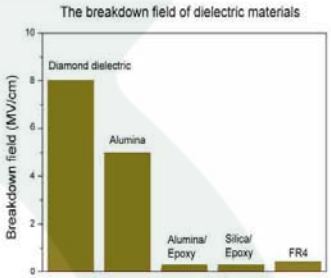
Diamond Insulation Heat Spreader

Galaxy designed electrical circuit



Materials Characteristics





The characteristics of dielectric DLC

Properites	
Thermal conductivity (W/mK)	~475
Thermal radiation	~0.88 W/cm^2 @70˚C
Electrical Resisstance (Ohm)	>10^{10}
Cofficient of thermal expansion (ppm/˚C)	7~9
Thermal stability (˚C)	~400
Chemical stability	No reaction wiht acids, alkalis, or solvents

Diamond Printed Circuit Board for High Power Devices

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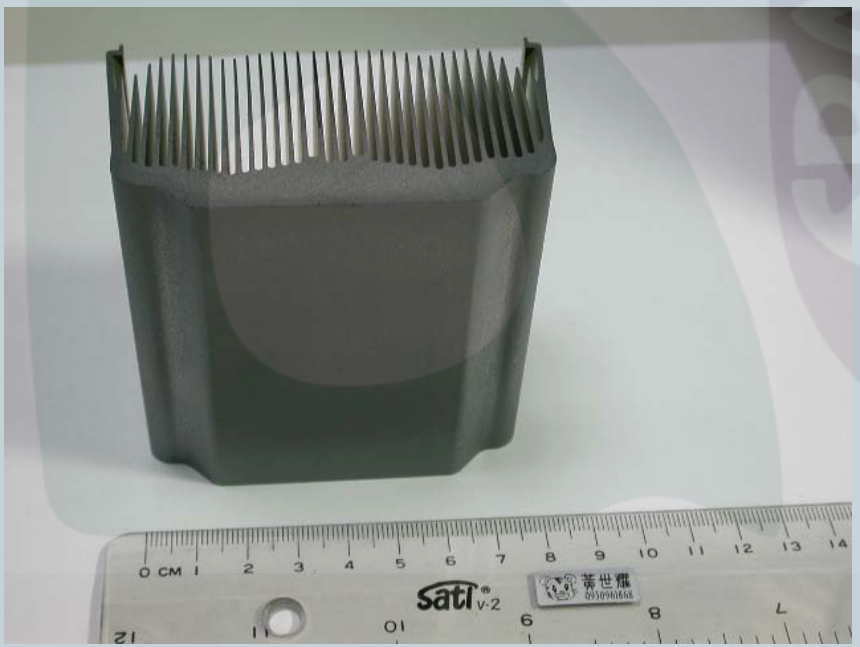
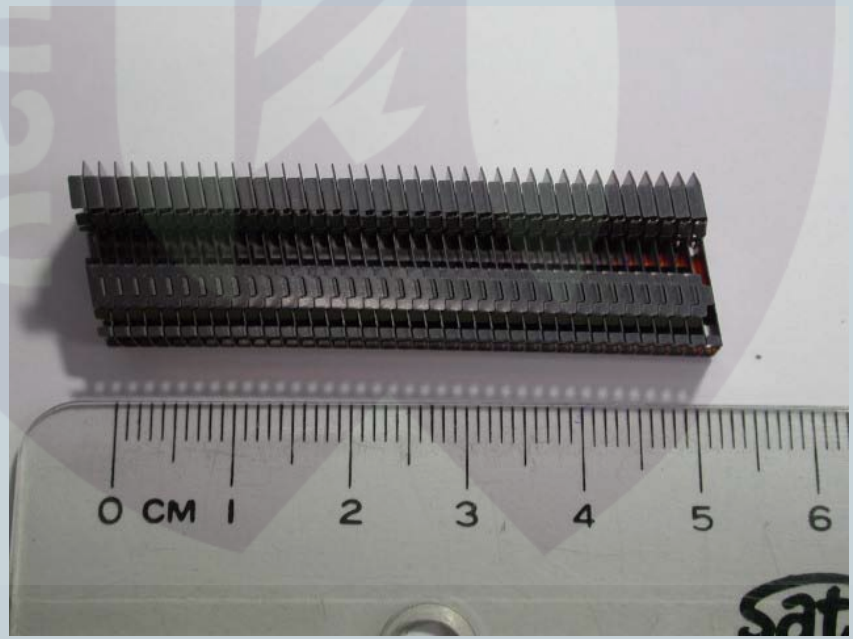
Heat Sink and Heat Pipe

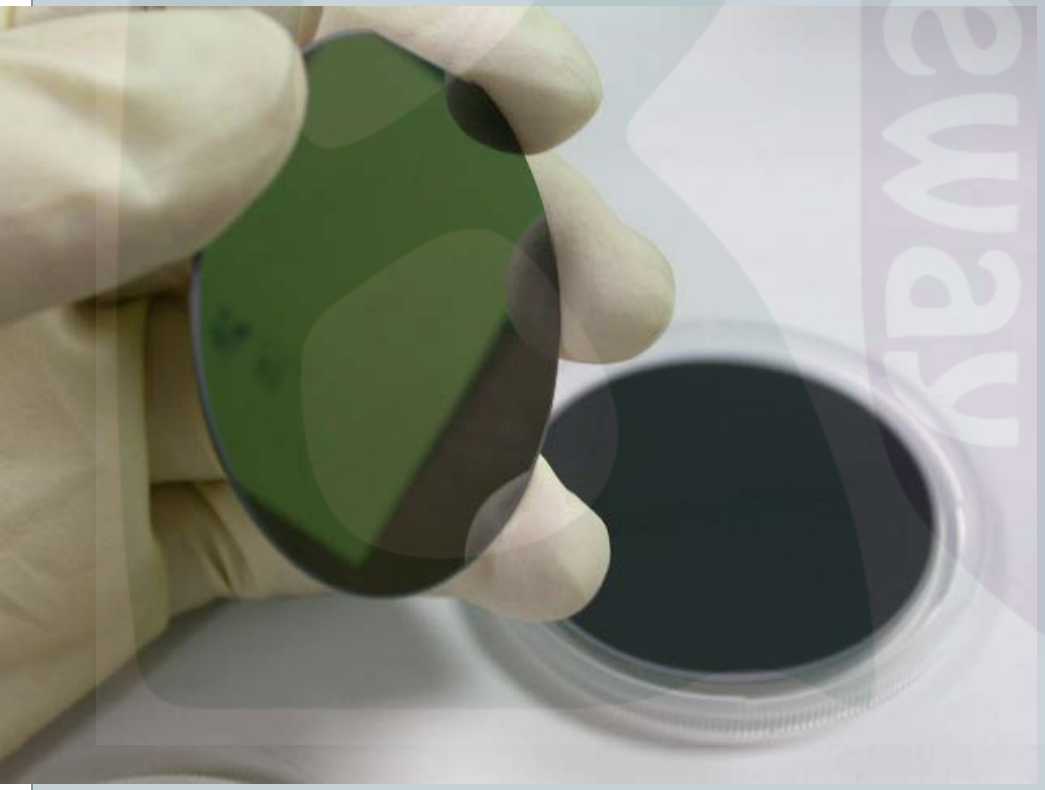




手錶機殼及錶帶

CITIZEN
Eco-Drive
CITIZEN
Eco-Drive
w.r.20 bar
Receive MODE
RADIO CONTROLLED
G-SHOCK
MODE

GaN/DLC/Silicon wafer 取代GaN/Sapphire



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台灣為什麼沒大量使用？

- 國內少有PECVD類鑽碳膜機台，大部分為Arc 及UBM Sputter。
- Arc及Sputter碳顆粒過大，只適合大型鑽針。
- 台灣能量產PECVD之DLC的廠家只有兩家。
- 本公司具有大型PECVD機台自行開發組裝能力。